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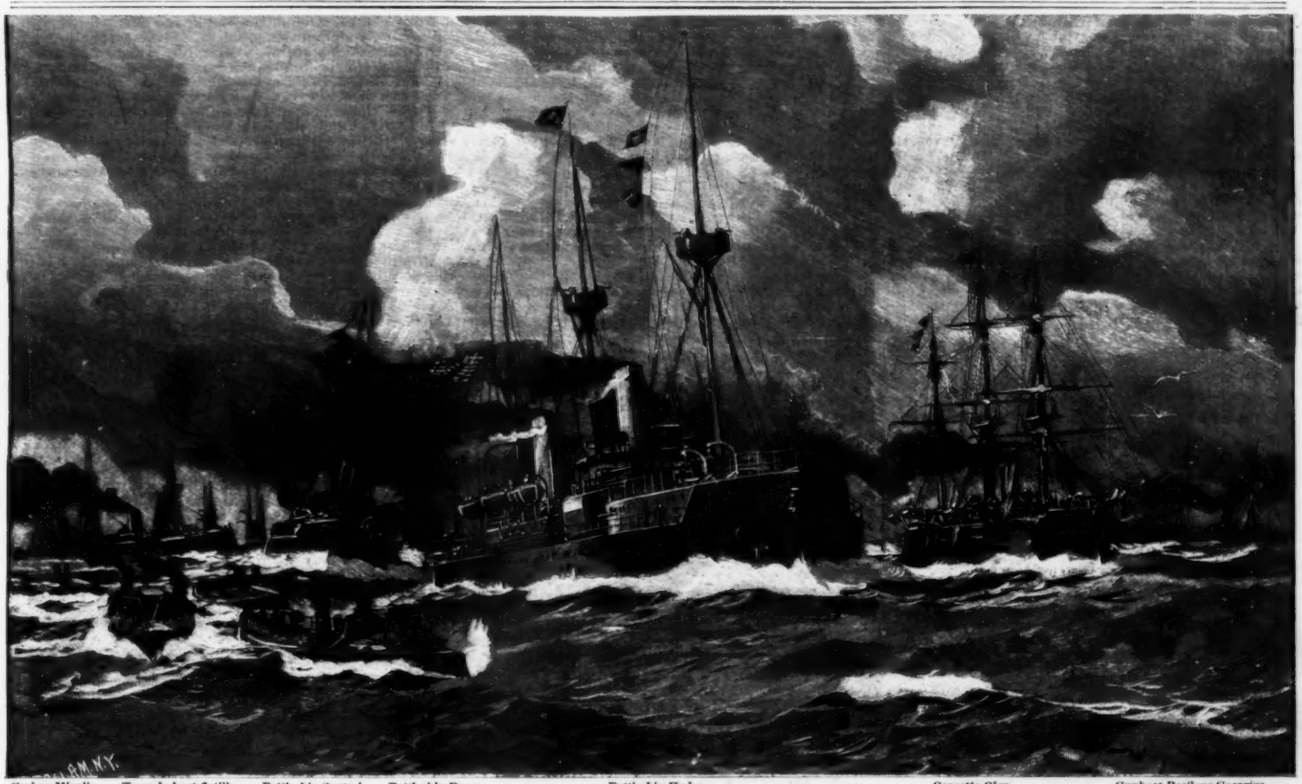
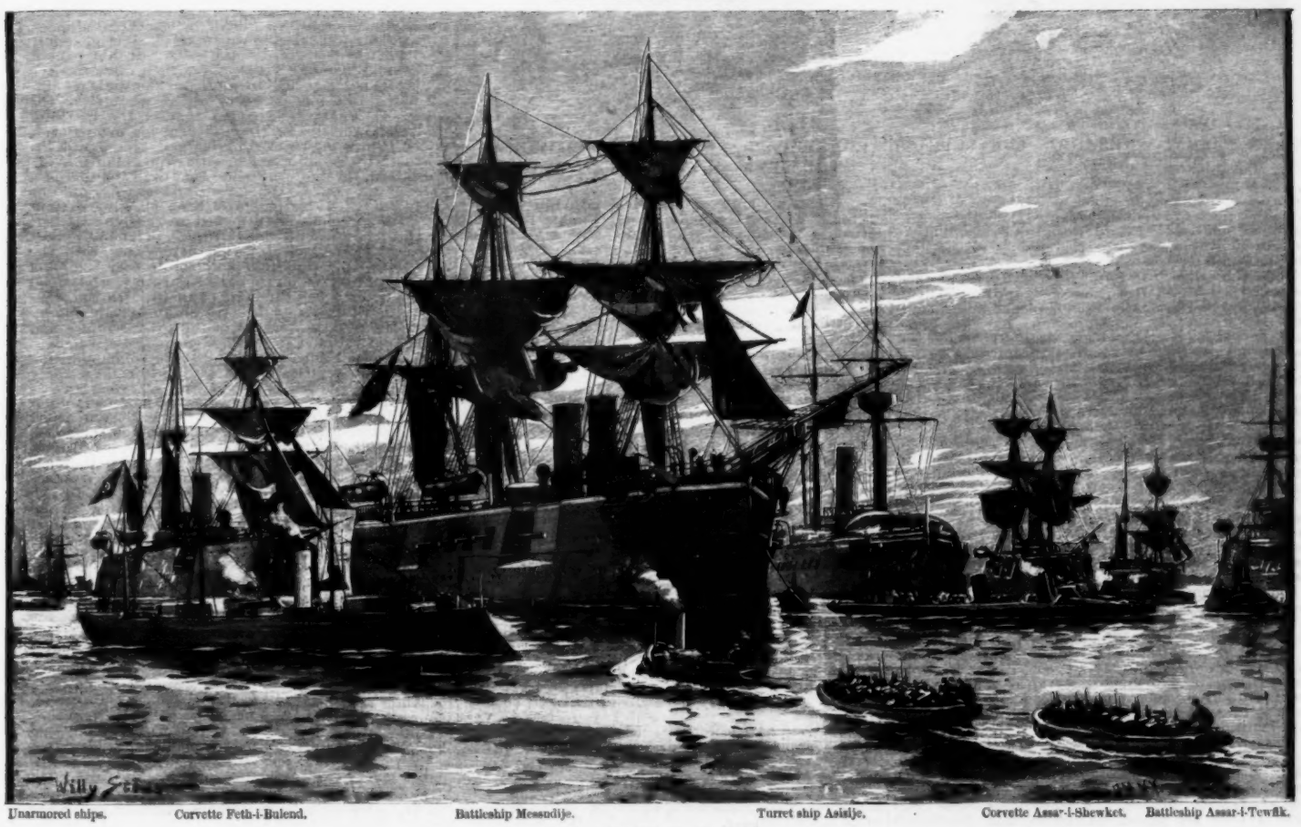


Cruiser Miaulis. Torpedo boat flotilla. Battleship Spetsai. Battleship Psara. Battleship Hydra. Corvette Olga. Gunboat Basileus Georgios.

THE GREEK FLEET.



Unarmored ships. Corvette Feth-i-Bulend. Battleship Messudije. Turret ship Asisije. Corvette Assar-i-Shewket. Battleship Assar-i-Tewfik.

THE TURKISH FLEET.

THE GREEK AND TURKISH FLEETS.

ACCORDING to official classification the Greek fleet is divided into several groups. There is first the operative fleet. Here the Hydra, Spetsai and Psara, three sister armor plated vessels, stand first. They are built similarly, each having a displacement of 4,885 tons, a length of 105 meters, breadth 16 meters, and a depth of 6 meters. The engines have 6,700 horse power each, giving the ship a velocity of 17 knots per hour.

The compound steel armor is 35 centimeters thick at the water line. Of the same thickness is also the armor tower. The inner horizontal steel deck is 5 centimeters thick.

Of the three heavy guns of 27 centimeters bore, two are placed in a front tower, the third in the rear. Besides, each boat has five guns of 15 centimeter bore and one of 10 centimeter bore, four light guns, ten quickfiring guns and one mitrailleuse complete the ordnance equipment, to which is added a torpedo armament. The steamers were launched in 1889 and 1890.

In the first class are also the cruiser Miaulis, the transport boats Mykale and Sfaktiria, four gunboats, the torpedo station ship Kanaris, and twelve torpedo boats. All these are without any armor protection. The cruiser Miaulis carries four long Krupp guns of 17 centimeter bore, four light guns, two mitrailleuses, and two small torpedo boats. It is a 1,770 ton vessel of 15 knots per hour speed. The engines have 2,200 horse power. The boat was launched in 1879.

The four gunboats have each one 12 centimeter Krupp gun, the torpedo station ship has two, the other boats have only mitrailleuses. The torpedo boats, which were built in 1881 and 1885, are rather antiquated, and have a velocity of 20 knots per hour.

Besides this operative fleet, Greece has command over a number of ships for coast defense. The first to be mentioned among these is the armored gunboat Basileus Georgios, 75 meters long, 11 meters wide, 4·4 meters in depth, of 1,774 tons displacement, and a speed of 12 knots per hour, given by a twin screw propeller, the engines being 2,100 horse power strong. She is armed with two 21 centimeter guns of Krupp's construction, four light guns and two mitrailleuses. Thirty-five years have elapsed since the building of the ship, but she is still serviceable.

Then there are two gunboats, the Amwrakia and Acteion, each with a 26 centimeter Krupp gun and two mitrailleuses. These boats were launched in 1881 and 1885 respectively, are unarmored, and have the same speed as the older armored gunboats. To the coast defense belong also three small iron boats, the Aegialia, Monemvasia, and Naupactia, each of 300 tons, intended for exploding mines. There are besides six torpedo boats of first class, two second class, and two old submarine boats of Nordenfeldt construction.

The covered corvette Hellas, the old armored corvette Olga, built in 1869, and a small sailing brig serve for training ships. The Hellas, which is intended for naval cadets, has two Krupp guns of 15 centimeters bore, a quick firing gun and 2 mitrailleuses.

There are finally twelve gunboats, and the royal yacht Amphitria. Of the gunboats, seven were built in 1884. The others are old hulks which were put to sea as early as 1856, the Kissa, Kiekli and Aidon being in addition to that nutshells of 86 tons displacement.

From this enumeration it will be seen that the Greek fleet is very small numerically, and that, moreover, it includes many ships unfit for use in open sea and in battle against vessels of modern construction.

Now let us turn to the Turkish fleet. The battleships Messudije, Hamidije and Assar-i-Tewfik are to be first mentioned. The first of these three is a 9,120 ton boat, dates from 1874, has twelve Armstrong frontloaders, three Krupp guns, six quickfiring guns and seven mitrailleuses.

The armor is 30 centimeters thick and is of iron. The speed of the three ships is only 13 knots per hour. The two other boats are smaller, the Hamidije 6,700 tons, the Assar-i-Tewfik 5,600 tons, but the former has compound armor plate of 22·9 centimeters. The main guns of each are placed on towers, and the heavy armament consists throughout of Krupp hindloaders. The Hamidije has ten 26 centimeters, two 15 centimeters and six 9 centimeter guns, besides two mitrailleuses. The Assar-i-Tewfik has eight 24 centimeter and two 21 centimeter guns, four quickfiring cannons and seven mitrailleuses.

Furthermore, there is a squadron of four turret ships of 6,400 tons, 3,735 horse power, and 12 knots per hour each. These were launched in 1864, and rebuilt 1892–1896; their names are respectively Asisije, Mahmudije, Orranije and Osmanije. Each boat has its heavy artillery in two turrets, with armor of 25 centimeters thickness, carries Krupp guns, two of 26 centimeters, eight of 15 centimeters, and six of 10 centimeters bore, four quickfiring guns and seven mitrailleuses and one small torpedo boat. Next, there is the turret ship Abdul-Kadir, of 7,873 tons, 11,500 horse power, with twin screws, and strong artillery. This ship is not yet launched and is in every respect up to date and fit for battle. Seven small iron plate corvettes of 2,000–2,800 tons are next on the list. They are the Feth-i-Bulend, the Mukkademe-i-Hair, the Awn-Illah, Muin-i-Saffer, Idshalje, Assar-i-Shewket and Nedshim-i-Shewket. The speed of these is 11–13 knots per hour; they are armed with heavy Armstrong frontloaders and Krupp guns, mitrailleuses and torpedo boats. They are useful as coast defense, but almost unprotected against modern artillery by their thin armor. Turkey has, besides, the double turret boat Hifs-i-Rahman, of 2,500 tons, which is only feebly plated, and carries Armstrong muzzle loaders, was built in 1868, and runs 12 knots per hour. Then there are two river gunboats, the Feth-ul-Islam and the Memduhije, of 330 tons, and the armor plated gunboat Hisber, of 400 tons, with two Krupp guns of 12 centimeters bore, two quickfiring guns and two mitrailleuses.

For coast defense Turkey has, besides the boats mentioned above, a torpedo fleet of three torpedo hunters, of modern construction. Two of these were built in German docks, one in Constantinople. Their speed is 19—22 knots per hour. Then two torpedo boat destroyers, built in Kiel, Germany; speed, 15 knots per hour. Fifteen first class torpedo boats, seven second class, one third class, and two submarine boats. Most of the torpedo boats were built in Germany. They represent the most modern part of the fleet.

Of ships unprotected by armor, which in our days are scarcely fit for naval battle, Turkey has eight cruisers, of which four may find use in cruiser warfare, owing to an interior protection by a horizontal armored deck; and twenty-eight gunboats, several paddle and screw steamers, boats for the transport of troops, and training ships.

The course of events in the war has given no opportunity to the Turkish fleet to take an active part, for the army, under the command of Edhem Pasha, though not without difficulties, won constant successes, and has now, after a series of victorious engagements, advanced deep into the enemy's land, where the help of the fleet would be unnecessary and useless.

That action on the part of the Turkish fleet was not considered necessary is evident from the fact that it has been kept in the home waters.

We also reproduce the portraits of the leading Turkish generals, Osman Pasha and Edhem Pasha. The former is about sixty years of age, and is known as the hero of Plevna. He first fought in the Crimean war, but his reputation as a great general dates from his victories at Plevna in 1877, and his stubborn defense of that place. The Sultan gave him the title of Ghazi (the victorious) in recognition of his worth.

Edhem Pasha is much younger than his great colleague, but he, too, was at Plevna, and has shown considerable skill lately as commander of the main Turkish army.

By his successive victories at Milouna Pass, Turnavos, and Domokos, he has reduced Greece to such an extremity that only the interference of the powers could save the Hellenes from complete disaster.

For the illustrations of the fleets we are indebted to Illustrirte Zeitung and for the portraits of the generals to Le Monde Illustré.

OSMAN PASHA, GENERAL OF THE TURKISH ARMY.

EDHEM PASHA, GENERAL IN CHARGE OF THE TURKISH ARMY IN THESSALY.

ARMY SIGNALING AND ITS USE IN WAR.

LIEUT.-COL. KENNEDY read a paper in the theater of the United Service Institution with the above title on Friday, April 30, Sir Redvers Buller being in the chair. Without entering into questions of military detail, there is much of interest to general and scientific readers. Signaling, the lecturer pointed out, appeared to lose its importance on the first introduction of the electric telegraph into operations of war. Yet it was clearly a necessary element in communication. Thus only can communication between shore and ships be made, and thus only can intelligence be communicated between exposed positions on service. Curiously enough, the electric telegraph was first used in the Crimean war by the allies, and sun flashing by mirrors was used at the same time by the Russian army. Sun flashing is, however, said to have been used in some primitive way by North American Indians and by the ancients. The lecturer did not say so, but we can hardly imagine Archimedes employing mirrors without their use for signaling coming in. In 1875 the Indian government adopted the heliograph, and it was used in the field in the Jowaki-Affridi expedition of 1877–78. In 1826 Lieut. Drummond employed the limelight in trigonometrical survey, this light being visible across the Irish Channel, a distance of 64 miles, and between Ben Lomond and Knock Large, a distance of 95 miles. In 1863 the late Sir Francis Bolton used a portable limelight apparatus, signaling between Dover and Calais and between the Crystal Palace and Aldershot. In the Abyssinian campaign of 1867–68 both the telegraph and signaling were employed with success, although the latter depended on flags, fog horns, hand lamps, shutters, and cones.

Communication in a campaign will depend fundamentally on the electric telegraph, which will form the base from which other systems branch off. It is liable to destruction, however, and although it has been used under circumstances when it was unprotected, it has suffered grievously from interruption. The Kyber line, for example, during the Afghan war of 1879–80, was cut ninety-eight times, and sixty miles of wire carried off. The telephone is considered by the lecturer less safe to depend on, owing to indistinctness in some voices. Signaling obviously offers special advantages in the case of advanced or detached positions. It can be used where no roads exist for transport of heavy guns, across water, and over the head of a surrounding enemy, as is now being illustrated by its use by the Greek force under Colonel Vassos in Crete. On the other hand, bad weather and to some extent unfavorable features of the country may interfere with signaling and it may be read by the enemy if not prevented by the use of cipher. The lateral range of the heliograph, however, limits the possibility of reading to a very narrow band of ground; at ten miles it is from 160 to 180 yards wide. Such objections as the possible disclosure of the presence of troops and the slowness of work seem hardly worth notice. Mounted orderlies and cyclists complete the usual means of communication. Balloons have a special part to play also. Written messages conveyed by mounted orderlies have the great advantage of being definite and of furnishing records for after reference. They are naturally limited in distance, slow of transmission, costly in the means required, and liable to failure from the rider being captured, killed, or losing his way.

The lecturer made what seems a valuable suggestion as to combining cycling men and signal men; to a certain extent, cycling being generally available over good flat protected roads, while signaling finds its chief use under the opposite conditions of mountainous and isolated positions, so that men might turn to the alternative required by the circumstances. In a country like India, where the sun is generally available, the heliograph has a value which it cannot possess in England. The lecturer then discussed the application of signaling in the field, and the best disposition of men for the work. As an example of the value of signaling, he stated that at the battle of Königgratz, at 1 p. m., the first Prussian Army Corps, under Prince Frederick Charles, had brought all its available troops into action without making any impression on the Austrian center, and was fighting hard to retain the position it had won, and on the right the army of the Elbe had likewise been checked, so that the Prussian commanders looked anxiously to the left for the coming of the Crown Prince, in ignorance that two of his corps had already been engaged with the Austrian army for half an hour within easy signaling distance of the rest of the Prussian army, who stood thus in ignorance of this state of affairs. On the other hand, the Austrians might have obtained valuable information as to the advance of the Crown Prince and made preparations to meet him by a good use of signals. For a long-continued defense, telegraph communication is valuable, but in case of retreat it is difficult to carry off wire and wagons too. The passage of a river is a case where signaling is specially valuable, mounted orderlies here failing to a great extent. The Russian army, on mobilization, has six fortress telegraph detachments, their duties being to work the telephones, telegraphs, and heliographs in the fortresses in which they are stationed. In the Chitral expedition, for a distance of 115 miles between Chitral and Jalala, 141 British and 124 natives signalers were employed, over 100 permanent stations being occupied. The total number of messages sent was 55,599, the longest direct heliograph signal distance was 87 miles. The work was heavy, but completely successful. The same successful result attended the use of signaling and telegraph on the Miranzai expedition in 1891, General Lockhart reporting at the conclusion of the campaign that the management of the work left nothing to be desired. It appears that in the Austrian service signaling consists mainly of a semaphore system used in hilly country. In France, flag signaling has been superseded by disks, and by day or night the Mangin lantern is used. In Germany signaling is not practiced, reliance being placed on mounted orderlies and cyclists. In Italy, balloons, optical telegraphy, or long distance signaling by heliograph, electric light, etc. The Morse alphabet is used. The Russians employ heliograph and telegraph, but in no Continental army does the flag system of signaling appear to be used. The United States use flag, heliostat, lamp, torches, ball, and collapsing drum.—Engineer.

LAUNCH ENGINE.

THE little engine of the Essh system, which we illustrate below, and which we consider of a particularly happy design, says Engineer, is driven by the vapor of petroleum—not exploded, but expanded in the same manner as the engine brought out for launches by Mr. Yarrow some years ago.

The engine, as seen by the cut, has three single acting cylinders working on to cranks at 120°. The vapor is distributed by three slide valves, actuated by the short throw cranks, c, c_1 and c_2, upon the rod, A. This rod is caused to rotate at the same speed as the engine by a train of three wheels, and to its end is fixed the reversing wheel, M. The upper wheel of the train is loose on the valve shaft, but can be made fast to the reversing wheel in two positions, which correspond to backward and forward running. The action is, of course, the same as with a loose eccentric, the relative position of the engine and valves being altered by the movement of the hand wheel. The arrangement of the distribution ports is shown in the side section, Fig. 2. The exhaust, it will be seen, is carried into the engine casing, of which all the joints are, of course, gas-tight, and passes from thence to condensing tubes outside the launch, and so back to the petroleum cistern. From here the petroleum is drawn by the pump, P, attached to the engine casing, is driven to the spiral system of tubes which constitutes the boiler, and enters the chest, B, in the form of vapor. From here the pressure is carried to the single valve chest by the vertical tube, D. A small portion of the vapor passes by the tube, T, to the injector, P, and descends by H, drawing in air with it through A, to the ring burner, K. Here, being ignited by a pilot light, it burns with a clear blue flame, the size of which can be regulated by the injector, P, to keep the pressure at from 14 lb. to 70 lb. per square inch, and so vary the speed of the engine. The density of the petroleum employed should be between 0·68 and 0·70. Below the former figure the petroleum does not lubricate satisfactorily, and above 0·70 it does not evaporate sufficiently rapidly. The consumption of petroleum is put at between 17 and 20 pints per hour, the speed 233 revolutions per minute, and the power 6 horse. The total cost of a boat fitted with this engine, and designed to carry two persons at about 5·5 knots an hour, is 11,000 francs, or £440.

A very interesting event recently took place in Melbourne, Australia, when the first horseless carriage was seen in the street. The vehicle is the property of the Horseless Carriage Syndicate and is provided with a small Britannia petroleum motor.

APPARATUS FOR SENDING WATER OF CONDENSATION AUTOMATICALLY INTO BOILERS.

THE saving in fuel that is effected through the collection of water of condensation and sending it into the boiler at a high temperature amounts to considerable in large manufacturing establishments. So we think it will interest our readers if we make known to them an ingenious apparatus that satisfies this condition automatically, and the operation of which is based upon a principle that is already known, but that has been hitherto applied with less success for the same purpose. It is a sort of pulsometer submitted alternately to the pressure of the live steam and to a depression due to the condensation of the latter in order to assure automatically the filling of the apparatus and then the emptying of it into the boiler.

We represent the apparatus in section. With the vessel, T, there is cast in a piece an open cylinder, r, containing a copper float, A, provided with guides. The annular space between the vessel and its cylinder is divided into two compartments, U^1 and U^2, which communicate with each other only through a small orifice, u_1, formed in the partition, u.

APPARATUS FOR SENDING WATER OF CONDENSATION TO BOILERS.

The condensed water enters through the conduit, N, which is provided with a check valve. At O the apparatus is put in communication with the water of the boiler and at M with the steam of the latter. As may be seen, the vessel, T, is surmounted with a cap, B, that constitutes an internal chamber whence starts a pipe, n, which enters the float. This chamber is, in addition, traversed by a pipe, m, which debouches below in the compartment, U_1, and above in a fixed pipe terminating in a cock, f, that permits of the escape of the air when the apparatus is set in operation. Finally, a central pipe, i, puts the vessel, T, in communication with the box of the check valve, g, which is connected with a screw that is maneuvered from the exterior by a handwheel, and may be opened by a central rod fixed to the bottom of the float.

This apparatus is placed upon the furnace of a boiler, so that the water may enter the latter through gravity.

The float and its receptacle, r, are filled with water, and the steam that enters them at the beginning is condensed. Hot water soon enters the vessel, T, through the valve, N, and its level rises more rapidly at U_1 than at U_2, by reason of the narrowness of the orifice, u_1.

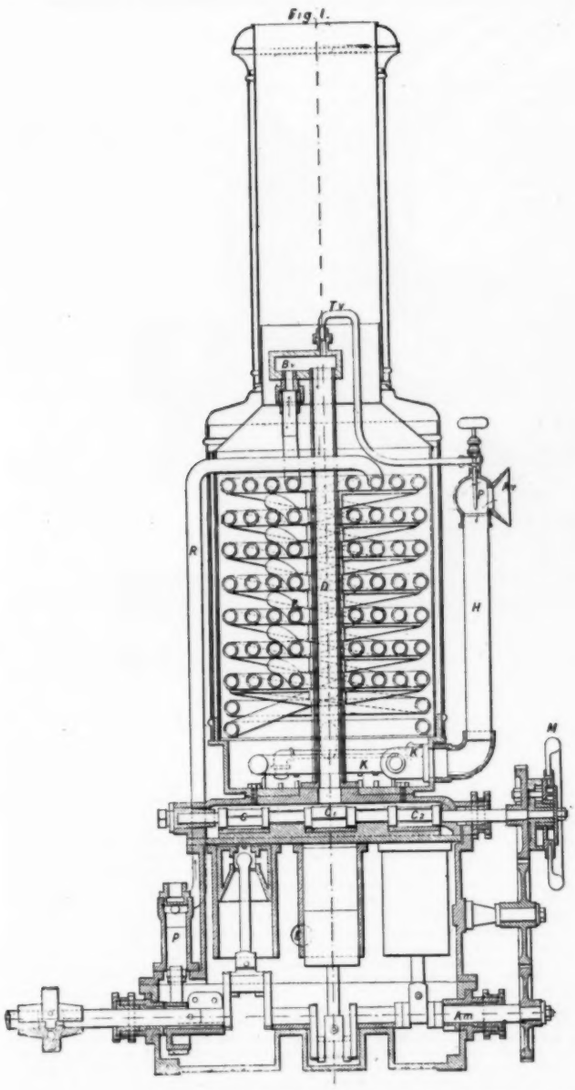
As soon as the water closes the lower orifice of the pipe, m_1, the vessel, T, no longer communicates with the chamber, B, wherein the steam condenses. The diminution of pressure resulting therefrom causes the ascent of the water into the pipes, n and m, and the float, A, gradually empties itself into the cover, B.

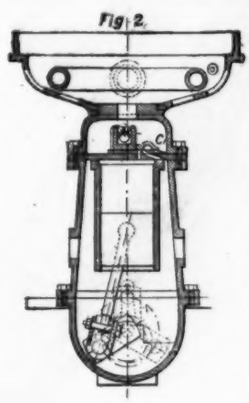
The column of water of the reservoir, r, tends constantly to raise the float, and the latter, in measure as it rises, receives an increasing ascensional force, which, after the float has been in great part emptied, is sufficient to bring about the opening of the steam valve, g. This is the way things proceed when the condensed water enters slowly; but if the discharge of the latter is abrupt, the liquid will flow over the edge of the reservoir, r, and communicate to the float an additional ascensional force which will hasten the opening of the valve. From the moment at which the latter is abruptly started from its seat (despite the resistance offered by the pressure of the steam) it will gradually rise until it is wide open.

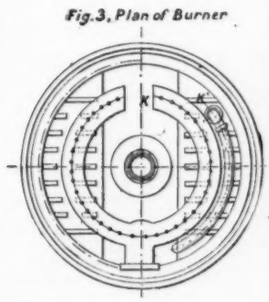
After this the apparatus will be submitted to the same pressure as the boiler, and the water under charge will flow into it through the conduit, O. The float preserves its elevated position during such flow until the lower orifice of the pipe, m, is again uncovered. At this instant the water that has risen to the cap returns to the float and causes it to descend. As the water flows more quickly from the compartment, U_2, than from U_1, the disengagement of the pipe, m, takes place when the first is nearly empty.

The result is that the overflow of the water due to the fall of the float in its cylinder exerts no influence upon the level in U_1, which is, moreover, protected against such return of the water by a superelevation of the crest, s, of the cylinder, r. In this way, a premature closing of the pipe, m, is prevented. It will be seen that the fall of the float is assured under all circumstances, and the same is the case, consequently, with the closing of the valve.

This apparatus is well adapted not only for the recovery of the water condensed or entrained in high pressure steam conduits, but also of that which forms in steam heating and cooking apparatus. It is only necessary to modify the diameter of the steam valve according to cases. A water gage permits of following the phases of the operation of the apparatus, that is to say, the ascent and descent of the water during the filling and emptying.—Revue Industrielle.





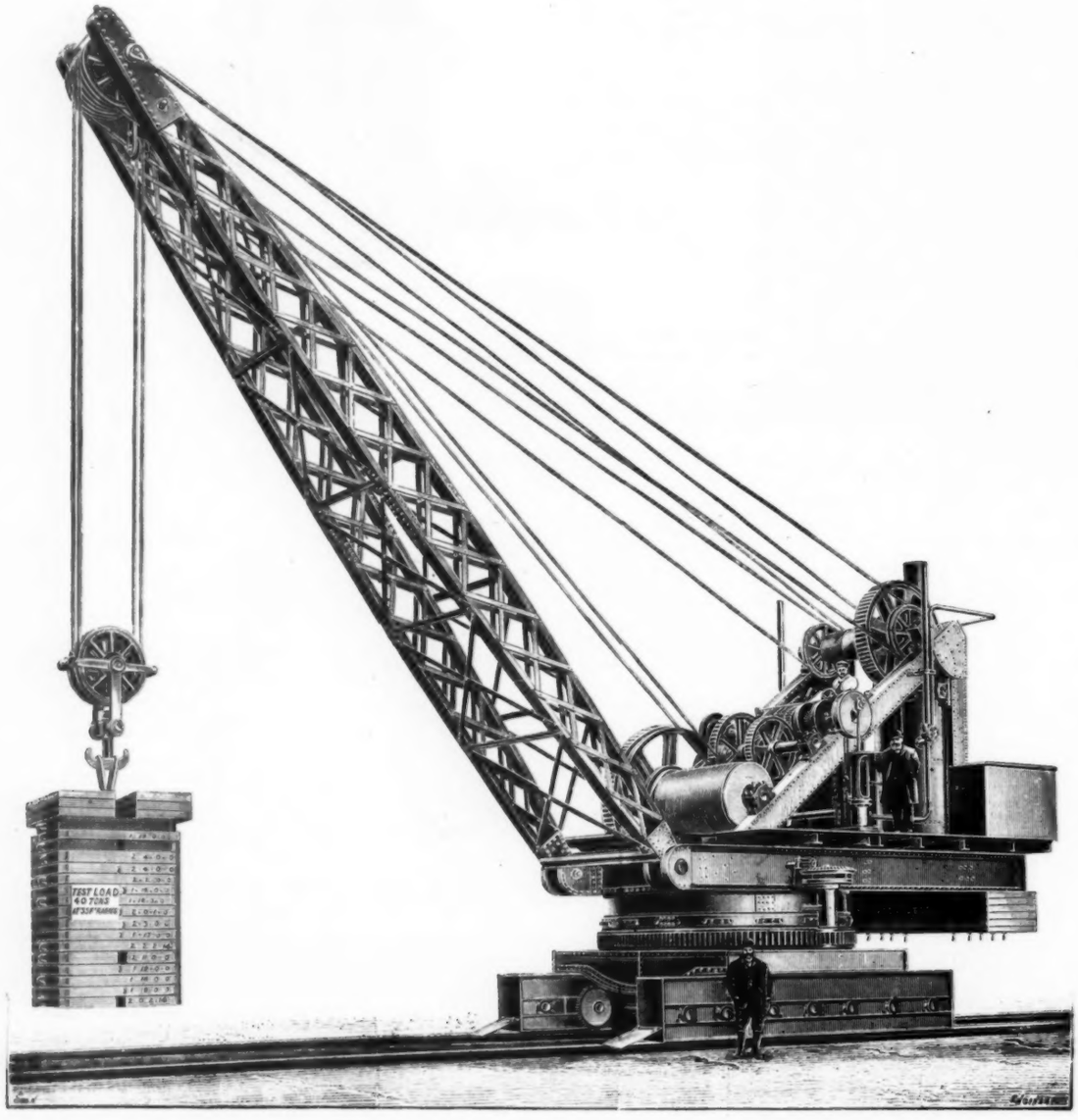


PETROLEUM VAPOR LAUNCH ENGINE.

Belgium has followed the example of Italy in adopting twenty-four hour time on the railroads and in the post and telegraph offices. It has resulted in endless confusion of time tables.

THIRTY TON STEAM TRAVELING CRANE.

THE crane which we illustrate is one of two machines which Messrs. Ransomes & Rapier, Limited, of London and Ipswich, are constructing for Messrs. S. Pearson & Son, for Vera Cruz Harbor works. The crane is intended for setting 30 ton concrete blocks, and also for working a dumper, to consolidate the rubble mound upon which the blocks are to be built. This novel departure we have already referred to in our issue of March 5. The gage of the crane is 11 ft. Each track is made up of two rails weighing 106 lb. per yard, the road wheels having a center flange, traveling in the gap between the rails; the twelve road wheels are thus practically converted into twenty-four. The weight of the crane is 126 tons. The carriage is built up of mild steel sections, with cross box girders resting on them, forming a most substantial base for the crane to turn on. Both roller paths are of wrought steel, the lower one having the turning rack bolted to it. The live ring is made up of thirty-two coned steel rollers. The jib and side frames are of mild steel, the gear being arranged so as to be easily accessible.



THIRTY TON STEAM TRAVELING CRANE.

The load is lifted by a four part extra flexible steel wire rope, winding two parts, on a turned grooved barrel, and is long enough to reach 60 ft below rail level. The derricking motion is also worked by steel wire ropes, after the manner now generally adopted by Messrs. Ransomes & Rapier. The turning and traveling gears have each a "spring driver" inserted in their train of wheels, which greatly reduces the stress which is brought upon the gearing when quickly or roughly handled.

The crane was recently very satisfactorily tested in the presence of Messrs. S. Pearson & Son's representatives, with a load of 40 tons at 35 ft. radius, under which conditions it was put through all its motions, with the load in any position, and without being propped up. This test represents a duty of 1,400 foot tons, and was carried out with great ease. With the working load of 30 tons the speed of lift was 37 ft. 6 in. per minute, turning a complete circle in one minute, and traveling on the rails 150 ft. per minute. The second crane referred to above is practically of the same design, but with a jib 60 ft. long, so as to reach to 50 ft. radius with a working load of 20 tons. In the first instance, this crane will be used on the works being carried out by Messrs. S. Pearson & Son at Port Talbot, but will finally be shipped at Vera Cruz.—Engineer.

ESTIMATES OF SIBERIAN RAILROAD TRAFFIC.*

AN event hardly less important than the cutting of the Suez Canal will be the building of the Transsiberian Railroad by Russia. Germany looks longingly forward to the time when fast trains are to run from Calais to Vladivostock. Five thousand miles of steel rails have been laid already at a cost of 350,000,000 rubles. July 1, 1904, it is thought, will see iron horses running from the shores of the North to those of the Japan Sea. In 1898 trains are to run over the Siberian road to the Amoor River. Thence, by fast steamer, passengers, post parcels, and freight are to be pushed on to Chabarowka; thence, in eighteen hours, over the South Russian section of the Siberian road, to Vladivostock, making the distance from London to the most important harbor of the Japan Sea seventeen and a half days. Many of the wares that go and come by boat now will find their way overland on these lines. Before 1901, Russia will have cut her way with steel rails across Manchuria, saving 300 miles. It is estimated by German engineers that when the road is repaired, after the first few years, and high rates of speed across Siberia are attained, the entire trip will be made in nine days and two hours.

The Anglo-Indo-Australian post bags weighed, in 1883 (the only year for which one finds figures), 842,448 kilograms. Last year England paid France and Italy for transporting the weekly post bags 1,400,000 marks ($333,200), at the rate of 2 francs per kilogram of letters and 25 centimes per kilogram of printed matter. Assuming that 650,000 kilograms were letters and 1,600,000 kilograms packages and printed matter, its importance to this empire will be apparent. The sphere of influence, apart from political or diplomatic interests, over which the great road is to extend lies east of the eightieth meridian east of Greenwich. It takes in all Japan, China, Australia, Annam, Siam, etc. If only half as much postal matter passes over the new line in 1901 as went via Suez in 1895, Germany will have to get 680,000 marks ($161,040) for transporting 325,000 kilograms of letters and 800,000 kilograms of printed matter and packages.

To no one does time mean more or so much as to a traveler to and from the East; 90 per cent. of the passengers will prefer to make the journey in nine to ten or twelve days overland to making it, as now, over seas in twenty-eight to thirty-eight days. This, too, when tickets from Warsaw to Vladivostock are to cost only 120 rubles, first class. From London to Warsaw costs now 150 marks ($45.70). Thus, the entire ticket (London to Vladivostock) is to cost about 500 marks ($119) first class. Of course, second class is to cost considerably less; how much is now not known. A ticket to Japan to-day, via Brindisi and the Suez, costs 1,800 marks ($428). If to the price of overland ticket the price of sleeping berth for twelve nights is added, there is even then a saving of $166 to $190 against the price now paid via Suez.

In 1895, 216,938 passengers went via the Suez Canal to China and Australia. For political, military, and other reasons, drop 117,000 from the list of possible passengers from the Russian route, and there remain 98,229. Take from these 18,299 pilgrims, and 80,000 remain. Take of these 40,000 who are East Indian travelers, and there remain 40,000 plus 10,000 who hitherto have gone via the American transcontinental lines, plus another 10,000 West Europeans who go annually to the East on business or pleasure, etc., and we get 60,000, mostly first-class passengers, using the new route. These must cross Germany from its western frontier to Alexandrowa, on the Russian border. Sixty thousand multiplied by 100 marks (from Aix la Chapelle to Alexandrowa costs now 92 marks) equals 6,000,000 marks ($1,428,000). The goods going over the road to the East and those coming west will be, naturally, those that can pay the biggest rates—furs, gold, silver, platinum, and tea. Many of these are to come to Europe out of Siberia itself. That land is rich in minerals of all kinds; the Urals are giving out gold and silver in large quantities. How important to Germany are the furs of Siberia may be learned at Leipsic's annual fairs. If the hammer that sent home the first spike in the first sleeper laid was silver, the one that sends home the last spike should be gold. Much as the road may mean to Germany, Russia, and the rest of Europe, it may mean more to us. California,

* United States Consular Reports.

Oregon, Washington, our whole Western country, if not our whole continent, is interested in this road. Russia has her hands full at home. The hands to help in the East are ours.

There is something more attractive in our civilization and methods to eastern people than in those of Europe; at least, this is asserted by eastern travelers. To develop the resources of an empire so vast as Russia will require capital, enterprise, and energy such as has made us the richest nation in the world. To equip her roads, to develop her great agricultural, fishing, mineral, and forest resources, Russia needs just such implements as have helped us. No time is to be lost if we are to have any part in the great drama that has for its plot the development and modernizing of the Orient. J. C. MONAGHAN, Consul.

Chemnitz, December 4, 1896.

SERPOLLET'S AUTOMOBILE RAILWAY CARS.

THE idea of a railway track always carries with it as a corollary that of a train running upon it, and, when it is a question of passengers, such train must, in addition to the cars designed for them, include a locomotive, a tender and a baggage car. This is certainly a large amount of rolling stock when it concerns lines of local interest doing a small traffic and upon which the receipts do not exceed in some cases two dollars a mile and per day.

The rolling stock is somewhat simplified by employing tank locomotives and mixed cars provided with compartments of several different classes, but the personnel of such a train always consists of a conductor, an engineman and a fireman.

An ideal light train should reduce to unity both the rolling stock and the personnel, and it is a step toward such simplification and saving that is made by the automobile cars elaborated by the Société des Generateurs a Vaporisation Instantanée, whose first specimen was experimented with last winter upon the Paris-Lyons-Mediterranean line between Corbeil and Malesherbes. This automobile car (Fig. 1) is, like a locomotive, driven by a motor with horizontal cylinder arranged under the frame and directly actuating the front wheels. The motor is supplied by a Serpollet instantaneous vaporization boiler heated by agglomerate briquets which reduce the fuel space to a minimum, and facilitate the stowing away of it. The automobile car weighs 17 tons in running order and is capable of carrying 44 passengers, thirty-two seated and twelve standing upon the rear platform.

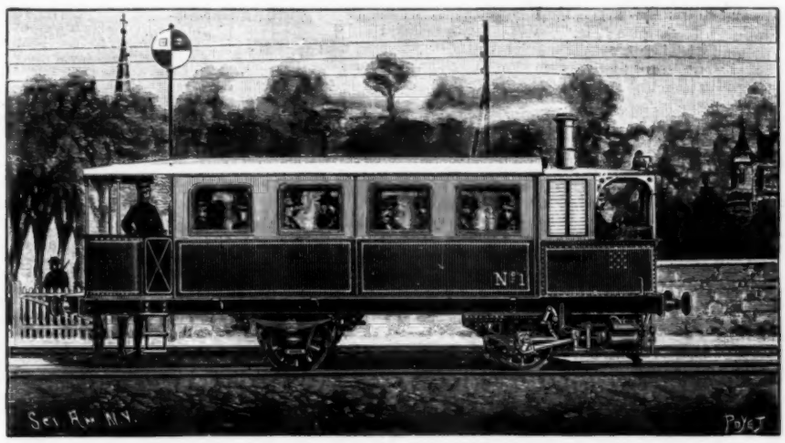


FIG. 1.—SERPOLLET AUTOMOBILE RAILWAY CAR.

The four wheels are 3·28 ft. in diameter, and the distance apart of their axles is 13 ft. The characteristic feature of the Serpollet boiler, as well known, is that of furnishing steam at a pressure that is essentially variable and proportionate to requirements, that is to say, to the tractive stress that the motor must exert at every instant, according to the declivities and resistances of the track. Thus, in a particular case, the boiler is capable of furnishing steam at a pressure of 230 pounds to the square inch, but a pressure of only 120 pounds to the square inch suffices to run the car with its 44 passengers at a speed of 30 miles an hour. Upon reducing the speed and increasing the pressure, the same car, upon the ordinary gradients of railways, is capable of hauling a second passenger car or a baggage car, as shown in Fig. 2.

The simplified rolling stock whose essential lines we have just indicated was realized for the first time with a view to performing service in Wurtemberg, and it was no small success for Mr. Serpollet to have obtained an order for French rolling stock in Germany.

Automobilism is now in fashion, and railway lines will have to submit to it every time that it is of interest to them to run light and frequent trains—tramway trains, in a word, which have been adopted for some years past by certain large lines in view of special requirements.—La Nature.

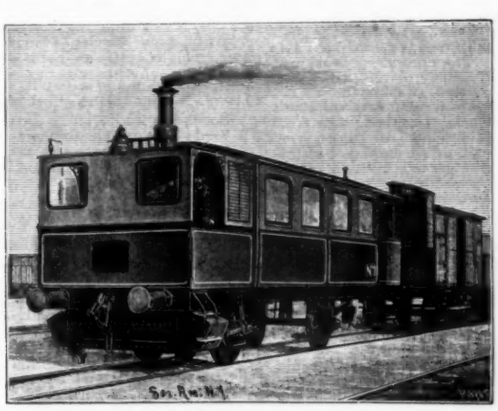


FIG. 2.—AUTOMOBILE CAR HAULING AN ORDINARY BAGGAGE CAR.

SIBERIAN RAILROAD EXTENSION IN CHINA.*

AT the beginning of the work on the Transsiberian Railway, the Transbaikal and Amoor section was planned to extend from China through Sretensk, on the shores of the River Shilka, to Pokrovskaia, thence along the northern shore of the river Amoor to Khabarovsk, to join the Ussuri Railroad [running south to Vladivostock]. But investigation clearly showed that the construction of a line in that section involved such technical difficulties as would greatly increase the cost of the undertaking. Thus, for example, on the Sretensk-Khabarovsk section, 1,667 versts (1,105 miles) long, the cost per verst (0·663 mile) would amount to the sum of 90,000 rubles ($46,260). This first raised the question of building the Transsiberian Railway through Chinese territory, and investigation made in Manchuria showed that it would not only cheapen and shorten the construction of the road, but would present other advantages. Negotiations were begun on this subject, and the result was that the Chinese government gave a concession to the Russo-Chinese Bank, and a new company, called the Eastern Chinese Railway Company, was formed, which is to construct and work a railway within Chinese territory. The articles of association of the new company were sanctioned by the Czar December 16, 1896, and by an imperial ordinance issued on December 23, 1896.

The details of the arrangement are these: The association has been organized on the strength of the convention concluded August 27, 1896, by the Chinese government with the Russo-Chinese Government Bank for the construction and exploitation of a railroad within the boundaries of China, from a point on the western frontier of the province of Heilung Chang to a point on the eastern frontier of Kirin, and to be connected with the branches of the Transsiberian Railway which the Russian government intends to build.

The company may, with the permission of the Chinese government, work, in connection with the railroad or separately, coal mines and other mining, industrial, and commercial enterprises in China. In case such enterprises should be worked independently of the railroad, then the company must keep a separate set of books for each of them. The Russo-Chinese Bank takes upon itself the duty of organizing this company, and when the same is organized all the rights and duties concerning the construction and exploitation of the line granted by the above-mentioned convention are conferred upon the company. The company will be considered organized as soon as the Government Bank presents to the minister of finance proof that the founders of the company have paid in the first installment of the shares, and they should be paid in not later than two months after the confirmation of the articles of association. The balance of the shares should be paid in, according to their nominal value, not later than a year after the organization of the company. Shares can be held only by Russian and Chinese subjects. According to the convention, the company will own the Chinese Eastern Railway during eighty years after the opening of the whole line.

The Russian government guarantees the resources of the company to the extent of making obligatory the payment of shares. The company takes upon itself, during the whole period of the concession, on the part of the Russian government, the following obligations:

(1) The Chinese Eastern Railway, with its appurtenances and rolling stock, must be always kept in full order to satisfy all the requirements of operation in relation to safety, convenience, and constant movement of passengers and freights.

(2) The traffic on the Chinese Eastern Railway to be kept up in conformity with the traffic on the Russian railroads connecting with the Chinese railway named.

(3) All trains of the Russian Transbaikal and Ussuri railroads are to be met by the Chinese Eastern Railway and forwarded to their destination without delay.

(4) The company binds itself to transmit, with a speed not less than that used on the Siberian Railway, all passenger and freight trains in direct communication with it.

(5) The company binds itself to construct and use on the whole length of the road a telegraph line, connecting with the telegraph lines of the Russian railroads, and to receive and send, without delay, through dispatches going from one frontier station to another, as well as telegrams going from Russia to China and the reverse.

(6) If, after the development of the operation of the railway, its technical arrangements shall not satisfy the requirements of a regular and uninterrupted traffic of passengers and freights, then, as soon as the Russian railways require the Chinese Eastern Railway to be reinforced, the latter must take suitable measures to improve its technical arrangements for the increase of its traffic. In case of a misunderstanding between the above-named railroads, the Chinese Eastern Railway agrees to submit to the decision of the Russian minister of finance. In case the means of the Chinese Eastern Railway shall not be sufficient to carry out the necessary improvements, the administration of the road can apply for pecuniary assistance to the minister of finance of the Russian government.

(7) For all transit transportation of passengers and freight and for the telegraphic communications, there shall be established, according to an agreement made between the company and the Russian government, a maximum tariff for the whole period of the concession, which cannot be raised during the above period without the consent of the Russian government. The limits for the tariffs of direct communication for railroad transportation, as well as for telegraphic communication, will be determined by mutual agreement between the administration of the company and the Russian minister of finance.

(8) Russian mail packages and officials accompanying the same are to be carried by the Chinese Eastern Railway Company free of charge. For this purpose the company assigns on each passenger train a part of one car, not shorter than 3 sagenes (21 feet); but the Russian Post Office Department can, should it so desire, furnish the railway with post cars constructed at its own expense, but the repairing and the keeping (except the inside fitting up) and the switching of them to trains must also be done by the railway company free of charge.

On the performance of the above-mentioned obligations depends the guaranty by the Russian government, and consequently the realization of the enterprise. After the eighty years' concession has expired, the road will pass, costs free, into the hands of the Chinese government. A sale of the railway by the company before the expiration of the concession does not in any way change the force of these obligations; they must be observed by the new purchasers of the railway to the full extent. Also, during the eighty years' concession the following rights given by the Chinese government to the railroad company remain in full force:

(1) The passenger baggage as well as merchandise transported in transit from one Russian station to another is not subject to Chinese customs duties and is to be exempt from all interior Chinese taxes and revenues.

(2) The tariffs for the transportation of passengers and freights, telegraphs, etc., to be free from all Chinese dues and taxes.

(3) Merchandise imported from Russia into China by rail, and exported from China into Russia the same way, will pay export and import Chinese duty one-third less than the regular duty paid at the Chinese sea custom houses.

(4) If the goods imported by rail are intended to go into the interior, they shall pay transit duty to the amount of one-half of the import duty exacted from them, and afterward considered free from any additional duties. Goods which have not paid transit duty are subject to all the interior taxes of the country.

The company is at liberty to buy the materials for the construction of the railroad wherever it sees fit. In case the materials are not purchased in Russia and pass through Russian territory, they will be free from paying the Russian customs duties.

The total amount of the capital of the company will be fixed in conformity with the cost of the construc-

* United States Consular Report.

tion, which is to be calculated according to the estimates founded on preliminary surveys. To the fundamental capital must be also added (1) the expenses for paying the interest and the amortization of the fundamental capital during the construction of the railroad, and (2) the outlay for purchase of the material obtained by the Russian government in a survey of a railroad in Manchuria, made by Russian engineers. The amount to be paid is subject to a mutual agreement between the company and the Russian minister of finance.

The capital of the company is formed by the emission of shares and obligations. The stock capital is fixed at 5,000,000 paper rubles ($2,570,000) and is divided into one thousand shares of 5,000 paper rubles ($2,570) each. The shares are issued at par. The Russian government does not guarantee these shares. For the remaining amount, the capital will be formed by an issue of "obligations" [bonds]. These "obligations" will be issued in proportion to requirements, each time with a special permit from the minister of finance. The nominal sum and value of each separate issue of "obligations," the time and conditions, and the form of the "obligations" are subject to approval of the Russian minister of finance.

The income and liquidation of these "obligations" is guaranteed by the Russian government. Regarding the realization of the "obligations," the company will have recourse to the Russo-Chinese Bank, but the Russian government has the right to keep for itself the obligationary loan according to the price fixed by the company and the bank, and to pay the company the fixed sums in currency.

The management of the construction and exploitation of the Chinese Eastern Railway, as well as the keeping of the books and accounts of the company, is left to the administration of the company. The offices of the administration are to be in Peking and in St. Petersburg, and meetings can be held at either of the two named cities. The administration is to consist of a president and nine directors. The president is appointed by the Chinese government. The other members are elected by a general meeting of the shareholders. The directors elect from among themselves one vice president. The company is to begin work in August, 1897, and the line is to be completed in six years.

The new line will begin at the Onon station of the Transbaikal Railroad and will cross the Chinese frontier near the town of Staro-Zurukhait; it will run in Manchuria toward the towns of Cicikar (Tsitsikar), Khu-lan-Chen, and Ning-tu and connect with the Nikolsk station of the South Ussuri Railroad. The total length of the Manchuria Railway will be 1,920 versts (1,273 miles), of which 1,425 versts (945 miles) will be in Chinese territory. According to the original survey of the Siberian line, the length of the road between the stations Onon and Nikolsk showed 2,434 versts (1,614 miles); consequently, the course through Manchuria will shorten the Siberian Railway 514 versts (341 miles), which is a great saving. Besides, the Manchuria line will go more to the south than the former Amoor direction (the difference in some parts being 600 versts=398 miles) through a country of better climate, with more productive soil. It will also cross the fruitful valley of the River Sungari, which supplies the Amoor region with bread. In general, northern Manchuria, which the new line will cross in the middle, possesses natural wealth, some of which to some extent is already worked. The agricultural industry forms the principal occupation of the Manchurian population; wheat, barley, buckwheat, rice, millet, pease, and maize are cultivated in considerable quantities. Manchuria poppy and tobacco are well known for their quality and the extent to which they are cultivated. Another important industry in that country is cattle breeding. Of mineral wealth, Manchuria is rich in iron ore, and, not long ago, work on gold mines was begun. On the line itself and its region in Manchuria are several large commercial points. Among the principal ones are Girin, Khailar, and Cicikar (Tsitsikar). Well-known annual fairs are held in Flandchur, in which northern Mongolia and northern Manchuria generally take the principal part, and also, to some extent, the Russian Transbaikal.

JOHN KAREL,
St. Petersburg, December 28, 1896. Consul-General.

THE PHOTO-STEREOSCOPIC FIELD GLASS.

WITH all photographic apparatus it is possible, with a multiple finder, to photograph a person without seeming to point the instrument at him; but all such apparatus show what they are, while the photo-stereoscopic apparatus represented herewith would not be suspected of being anything but an ordinary field glass.

FIG. 1.—PHOTO-STEREOSCOPIC FIELD GLASS.

A single tube, the one to the left, is designed to operate through a lens, b, forming the ocular, a ground glass, c, an oblique mirror, d, and a small objective, e, which gives the visual ray an angle of 90 degrees with respect to the axis of the tube, A. The lens, b, is designed for magnifying upon the ground glass the image that comes from the finder. In the tube, A, are arranged two objectives, B and B', between which there is sufficient space to allow the shutter to effect its travel. It is easy to use the apparatus. It suffices to press a button placed upon the tube of the apparatus in order to free the shutter from a catch beneath and allow it to move to one above. A second button then becomes apparent, and it is necessary to push this in order to set the shutter free again. The plate magazine consists of an oblong box, X. The upper extremity is covered by a flexible pocket provided with two apertures that allow of the passage of the plates that have received an impression and that are extracted

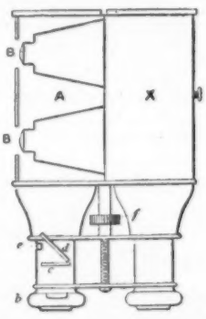


FIG. 2.—SECTION OF THE APPARATUS.

from the magazine by an appropriate arrangement. The magazine holds twelve plates, which are continuously pressed at the objective end by a spring. A third and opaque plate is placed above the twelve others, and this permits of the introduction or removal of the magazine in broad daylight. The tube to the right is occupied by a counter which, actuated at every negative taken, gives the number of sensitized plates. The focusing is done through the wheel, f. The best distance for operating is five feet.

If it is desired to obtain but one simple photograph, and not a stereoscopic one, it is only necessary to mask one of the objectives with the hand.—L'Illustration.

According to Swedish official mining statistics for the year 1895, the amount of rock ore worked was as follows, says the Colliery Guardian: Iron ore, 1,901,971 tons; gold ore, 459 tons; silver and lead ore, 12,045 tons; copper ore, 26,009 tons; zinc ore, 31,349 tons; manganese ore, 3,117 tons; iron pyrites, 221 tons. The lake and marsh ores (amounting to 2,691 tons) are not included in the above figures, so that the total production of iron ore was 1,904,662 tons. The amount of the different sorts of iron produced during 1895 were as follows: Pig iron, 462,930 tons; puddled iron, for rolling, 188,726 tons; Bessemer ingots, 97,294 tons; Martin ingots, 96,475 tons; cast ingots, 551 tons; iron and steel bars, 168,270 tons; iron and steel hoops, rods, etc., 78,168 tons; wire rods, 26,038 tons; sheet iron, 12,022 tons. The blast furnaces, during an average of 252 days, showed an average output per furnace of 3,171 tons, or about 12·58 tons per day. Charcoal is, from a practical point of view, the only combustible used in the blast furnaces of Sweden; only in very rare cases, as in the manufacture of spiegel, it is mixed with a little English coke. The coal mines, situated exclusively in the most southern province of the kingdom, yielded an output of 223,652 tons of coal in 1895, or 27,702 tons more than in 1894. In these mines there are found strata of fire clay, which, worked partly with the coal, yielded, in 1895, 120,385 tons of clay, or 9,232 tons less than in the previous year. The number of workmen employed in the mines and furnaces in 1895 was 26,284, or 832 more than in 1894. Of these, 5,499 men and 227 children under eighteen years of age were employed under ground, and 18,162 men, together with 2,406 women and children (under eighteen), at the surface. The number of machines and motors employed in 1895 in mines and mineral workings was 1,621, of 57,888 horse power. With regard to accidents, the total number was 80, of whom 49 were killed and 31 injured. The total number of licenses for the working of mines granted in 1895 was 417, of which 201, or 48 per cent., were for the working of iron mines.

Mr. C. H. Mitchell, of Toronto, Ont., suggests the use of scrap or refuse mica in making coverings for boilers and steam pipes, where its properties as a non-conductor of heat will be valuable. Another use is as packing or protection to walls or roofs exposed to heat, or in other locations as a fireproof material, says the Engineering and Mining Journal.

SELECTED FORMULÆ.

To Remove Oil Colors or Varnish.—A foreign journal—the Bautechnische Zeitschrift—publishes the following: Where oil colors or varnish are to be removed from the surface of floors or furniture, it is usual to treat them with soda. As a rule, a solution of ordinary washing soda is employed, and applied cold. This in time accomplishes its task, but its action is slow and not very efficient. A far better way is to use caustic soda, which can be bought in iron cans, and use the solution hot. With a hot lye of this sort oil color can be removed in a few minutes, and varnishes nearly as rapidly. As the solution attacks the skin, it should be applied with a cotton or hemp swab. A bristle brush is useless for the purpose, as the bristles dissolve almost immediately in the lye, leaving nothing but the handle of the brush, while cotton or hemp are not affected. When the wood is clean, it should be well washed with water. The strong soda lye darkens the color of oak, but, if this is objectionable, it can easily be corrected by brushing the wood over with dilute muriatic acid, washing it thoroughly as soon as the color is satisfactory, and finishing with a weak solution of soda, to neutralize the last traces of acid. In applying the acid, neither cotton nor hemp can be used, as they are quickly destroyed, but bristle brushes are not affected, unless they are bound with iron. In general, care should be taken never to use muriatic acid in rooms or workshops where iron tools are lying about, as the vapor, even from dilute acid, is quickly diffused through the rooms, and attacks all iron or steel that it can reach. The best way is to make all acid applications in the open air. It is hardly necessary to say that cotton or linen clothes should be worn in using the soda lye, as a drop of lye, falling on woolen cloth, immediately makes a hole.—National Builder.

Sterilizing Dental Instruments.—Martin (Essentials of Surgery) recommends the following treatment for all surgical instruments: Brush with a solution of carbolic acid (1·20); sterilize by roasting, boiling, or by storing for one hour in 1-20 carbolic acid solution. During the operation keep in a 1-40 carbolic solution. To prevent rusting boil in 1 per cent. solution of sodium carbonate. A very effectual method is to place the instruments in metal boxes and heat in an ordinary oven (200° F.) for half to one hour; they may then be used dry. Rusty instruments may be cleaned, says a medical exchange, by first rubbing them with wood ashes and soft water. Then soak them in a weak solution of hydrochloric acid in water (about 10 to 15 drops to the fluid ounce) for a few hours, to remove the rust and grease. Then wash them well in pure soft water. The next step is to place them in a bath consisting of a saturated solution of tin chloride. Let them remain ten to twenty-four hours, according to the coating desired. When removed from the bath, wash them clean in pure water and dry well. When the job is done, the steel will appear as if nickel plated.—Pharmaceutical Era.

A Hint for Amateur Photographers.—The Belgian Photography Association Bulletin gives the following formula for absorbing the yellow green rays on isochromatic plates, and preventing the "photographic halo" which is the despair of amateurs, the preparations which are usually put on the backs of plates being insufficient:

Collodion, 2 c. c., p. 100	100 grammes
Erythrosine	0·3 "
Aurantia	0·3 "
Castor oil	2 c. c.

Can be washed off after finishing.

Yellow Screens for Isochromatic Work.—Yellow screens for iso work may be made, according to M. Leon Vidal, by fixing an unexposed plate, washing well and drying, and then immersing for some minutes in a 1 per cent. solution of picric acid to which sufficient ammonia has been added to make it smell faintly, and then drying.

Patent Leather Varnish.—A varnish that will not peel off or crack from the leather is a desideratum, and one that should sell through chemists, and bear a good profit. Such a one is, according to the Trade Recorder, to be made from following formula:

Rosin, black	7½ ounces
Venice turpentine	7½ "
Oil of turpentine	7½ "
Sandarac	15 "
Shellac	1 lb., 14 "
Alcohol	11¼ pints
Lampblack	4 ounces

Digest the rosin, turpentine, sandarac, shellac, and alcohol together, afterward add the lampblack, and well mix. Apply with a soft brush.—Magazine of Pharmacy.

Fermented Ginger Beer.—For a good recipe for fermented ginger beer to put up in stone jugs, take

Best Jamaica ginger, ground	1 pound
Tartaric acid	6 ounces
Gum arabic	1 pound
Oil lemon	½ ounce
Sugar	21 pounds
Water	21 gallons
Yeast	¼ pint

Stir the ginger, sugar and water very thoroughly together. Dissolve the gum in sufficient water to give it the consistency of cream; to this add the lemon oil and shake them well together. Add this mixture to the sugar solution. Now stir in the yeast. As soon as a brisk fermentation is established, strain through a jelly bag. Let it work for another day or two and then bottle. This will make 20 gallons—you can double or quadruple the proportions if you want to make a larger batch.

Soap for Metals.—

	Parts by Weight.
Cocoanut soap	100
Chalk	8
Alum	3
Cream of tartar	3
White lead	3

Cut the soap into slices, and melt it in an iron vessel, adding a little water. When the soap is thoroughly melted, add the other ingredients, mix the whole thoroughly for ten to fifteen minutes, then run it into moulds of white metal.—Bulletin of Pharmacy.

ENGINEERING NOTES.

The motor car is evidently beginning to wane in popularity in France. The number of second hand automobile machines which are offered for sale is daily increasing, says The Road, but M. Vuillemot, proprietor of a motor car journal, says that this is nothing of the kind—that amateurs are anxious to keep up with the times and buy new models.

It is again suggested that a subway be built to connect all the Chicago railway stations. The suggested diameter of the subway is fourteen feet; the subway would be sunk thirty-five feet below the surface. The trolley or compressed air system is recommended; the passengers to be transferred in cars holding twenty-five persons each, at a fare of five cents each. A company with a capital of $10,000,000 is being organized.

An unusual experiment was recently made with a certain famous locomotive of the New York Central and Hudson River Railroad. The engine was taken into the shop and completely overhauled. Every part of it, from the driving wheels to the most diminutive bolt, was separately weighed. The workmen, says Modern Machinery, were most painstaking in regard to obtaining absolutely correct weights. After a time the engine was again taken to the West Albany shops and the mechanics again dissected it. Again every part was carefully weighed and the record compared with the former one. In this way it was discovered just how much the engine had lost in weight after having done a specified amount of work. The records of the weights of the separate parts also showed which parts were subjected to most wear.

The Snowdon railway has been formally reopened, and passenger trains are running as far as Clogwyn with perfect regularity and safety, says the Trade Journals Review. The remainder of the line to the summit will soon be rendered equally safe for all kinds of traffic. It will be remembered that the opening of the line some twelve months ago was marred by a sad accident, such as natually had the effect of shaking public confidence in mountain railways. The permanent way of this line has now undergone reconstruction, and it is believed that an accident of the kind will be impossible in the future. The sum of $45,000 has been spent in laying down a safety guard along the whole track. This guard, which is the invention of Sir Douglas Fox, consists of an additional rail of T section which can be powerfully gripped by the engine and by each carriage of the train. It is to be hoped the ensuing summer will witness the commencement of that prosperity which this bold undertaking deserves.

A useful report has recently been issued by the Steam Users' Association of Boston, U. S. A. In the section of the report dealing with the cost of boiler room labor it is stated, as the result of comparison between a large number of steam plants, that one man—besides night man—can run a small engine and stoke up to about 10 tons of fuel per week; that one fireman—besides engineer and night man—can stoke up to about 35 tons per week; while three firemen can stoke up to about 80 tons per week. Mechanical stokers save 30 to 40 per cent. of labor in very large plants—over 200 tons of fuel per week; 20 to 30 per cent. in medium-sized plants—50 to 150 tons per week; and save no labor whatever in small plants. The eight hour day—in 24 hour plants—is only about 10 per cent. less efficient in tons per man, for manual stoking, than the 12 hour day, though the evidence of this is derived from very limited data. Men wheeling barrows of coal, in charges of 300 lb. per barrow, can handle 112 tons per week—60 hours—per man, on a five yards' wheel, 90 tons per week on a 25 yards' wheel, and 72 tons per week on a 50 yards' wheel, including filling, weighing and emptying, according to the Electrician. The foregoing figures are based on American practice.

The board of harbor commissioners of San Francisco believes that it has at last found a pile that will withstand the ravages of the voracious teredo, says the Railway Review. A teredo-proof pile driven in October, 1886, and an ordinary fir pile driven in April, 1894, were both recently taken up. The common pile was so badly damaged by the inroads of the teredo after having been down but two years that, when laid on the wharf, it broke in two with its own weight, while the teredo-proof pile, which had been driven for nine years and six months, was found to be nearly or quite as sound as when it was first driven. The construction of this pile is simple. In the center is a piece of timber 6 in. square, about which are secured strips or boards secured alternately at right angles to each other until the proper thickness of diameter for the pile has been reached. In building the pile the center core is first smeared with a preservative compound made of either asphaltum, coal tar, or a similar substance that prevents the decay of wood. The strips are then nailed on opposite sides of the core, being first coated with the preservative compound. The outer surface of the completed pile is protected by an exterior coating or layer of the preservative compound.

Since about 1860 the sidewalks of Prague and of other cities of Bohemia have been made in a mosaic of light and dark limestone cubes, which are considered of pleasing appearance. This industry flourished most about fifteen years ago. Then the competition of artificial stones and chamottes made itself strongly felt. But in the quaint, picturesque capital of Bohemia the mosaic pavement is still in favor. The origin of this custom is curious. During the forties water pipes were made of red Sliwenetz marble, bored; the pipes did not answer, and a mason, Zak, is said to have hit upon the happy thought of utilizing the stone pipes in the manner mentioned. For some time afterward, limestone was actually brought to Prague, there to be converted into mosaic. It is rather curious, too, that Dr. F. Katzer, who directs attention to this industry, is chief of the Museo Paraense in Brazil. His articles in the Oesterr. Zeitschrift für Berg. und Huttenwesen have, however, a more practical than artistic interest. He deals with the matter from the lithochreiological standpoint; that is, he examines the hardness and firmness of the stones, their wear under friction and under blows, etc. There is too little done in this respect, and too little agreement concerning the methods of testing paving and other materials.

ELECTRICAL NOTES.

After a series of thorough investigations the authorities of Glasgow, Scotland, have decided to introduce the overhead trolley system.

The electrical tramway through Cairo, Egypt, has been very successful, though the rates of transportation are extremely low, in some cases being only two cents for a distance of three miles. The electric lighting is also to be extended.

An electric railway between Cordova, Mexico, and Jalata, is approaching completion, and, according to the Electrical World, 2,000 men are now employed on the work. This, it is stated, is the first electrical railway in Mexico and is seventy-five miles in length.

A short article in the Zeitschrift für Electrochemie calls attention to the possible utilization of the large peat beds in Germany. It is stated that thirty tons of peat will produce one ton of carbide, so that the calorific equivalent of 30 tons of peat can be condensed into one ton, thus greatly reducing the cost of transportation.

At Niagara Falls, says the Practical Engineer, about 15,000 horse power are at present available. 7,200 horse power have been taken by a paper making company, 3,050 for aluminum, 1,000 for carborundum, 1,075 for acetylene (carbide making), 500 for the electric lighting of Buffalo, 500 for chlorate of potash, 400 for peroxide of sodium, 500 for railways between Niagara Falls and Buffalo; and large extensions will have to be made, for contracts have been signed for 2,000 horse power for Buffalo street railways (at a distance of 22½ miles), 4,000 for acetylene, 2,000 for calcined soda, 3,000 for Buffalo electric lighting, and 400 for an electrochemical works.

Messrs. Remy & Contremoulin have presented to the Academy of Sciences a new result of their researches on the application of the X rays to anatomical study. With the aid of chemical preparations they have put the muscles, ligaments and tendons of dead bodies, both of men and frogs, in such condition that they have given radiographic images. The muscle appears of a somber shade that reveals its full outline, but within the boundaries thus indicated are perceived still darker portions that correspond to muscular bundles. The muscle is masked by bundles of longitudinal fibers, very clearly outlined. The muscular tendons show very clearly in many cases, and some interosseous ligaments are also seen plainly.—Cosmos.

At a recent meeting of the Physical Society, T. A. Garrett and W. Lucas communicated the results of some experiments upon telephones with nickel magnets. A magnetized nickel rod is wound with insulated wire and then fixed vertically by a clamp at its lower end, while a pinewood diaphragm is rigidly attached to the top of the rod in a horizontal plane. The rod just passes through the middle of the diaphragm, which is entirely supported by it, and fixed with sealing wax. The instrument does not work well as a "receiver," an ordinary telephone being preferable for that purpose. The nickel "stress" telephone, however, gave better articulation than an ordinary "watch" telephone, though the sounds were feebler and the articulation was clearer with three cells than with six.

A booster consists of an armature driven in a magnetic field and through whose windings passes the entire current of the circuit in which it is placed, its object being to increase the voltage of the circuit. Usually there is a combination of two direct connected machines, one of which acts as a motor and drives as a dynamo the other machine or booster. Sometimes there is a single field with the motor and booster windings on the same armature. A booster may be used on an electric railway feeder leading to a distant point, in order to raise the E. M. F. of that feeder sufficiently above the station E. M. F. to compensate for its abnormal drop; or in an auxiliary storage battery installation to add sufficient E.M.F. to the dynamo voltage to charge the cells.—American Electrician.

A statistical table on the Austrian telephone service at the end of 1896 is published by the Electrotechniker, of Vienna. The table gives length of the lines, the intermediate stations, and the day of opening. The summary adds a few more figures. At the end of 1896 (we add the figures for 1895 in parentheses) there were 146 (124) telephone networks with 351 (287) public offices, and 20,556 (18,091) subscribers; about half that number, 73 (53), were lines between different towns. The lengths of the lines aggregated 6,387 (4,358) kilometers (a kilometer is 0·62 mile). It must be understood that these numbers refer to Austria proper only, not to Hungary, and not to the extension of certain lines across the Austrian frontiers. Thus the line Vienna-Berlin is only reckoned to the Bohemian frontier. The oldest lines date from 1888; there are some of 1890 and 1891, after which year the development has been more rapid. It will be noticed that the additions of the last year almost entirely refer to interurban as distinct from suburban lines.

An experiment in electric traction is about to be made on the Belgian state railway line, nine miles in length, extending from Brussels to Tervueren. According to L'Electricien, five large accumulator cars will be operated in addition to the present steam service. They are to run at a speed of 18½ miles an hour on the steepest gradient—16 per cent.—and at 31 miles an hour on other parts of the line. Each car will be 52½ feet long, and there will be room for 80 passengers. There are two motors on each car. The motors will weigh from eight to nine tons, the cells 12 tons, the other electrical apparatus one ton and the car 20 tons. Three Julien and two Tudor batteries have been ordered, each of 264 cells. The former are designed to make three or perhaps four journeys without recharging, the latter only one journey. In the latter case, however, the time required for charging is limited to one hour, while for the Julien battery six hours are required. The cells are in 24 drawers, 11 being contained in an ebonite box in each drawer. The following named firms are supplying motors for these trials: Jaspar of Liege, Pieper of Liege, Schuckert of Nuremberg and Thury of Geneva. The motors will be compound wound. The cells will be charged by a Willans engine and dynamo, erected on a car drawn by an old locomotive.

MISCELLANEOUS NOTES.

The export of butter from the United States to Europe has risen in 1896 from 9,539,000 pounds to 21,933,000. These figures show an increase of over 100 per cent.—Uhland's Wochenschrift.

In a recent shipment of platinum to Baker & Company, the Newark refiners, there was a nugget, roughly 3 by 2¾ inches, and of nearly two pounds weight, which is the largest nugget of that metal ever seen in this country. For some time it has been on exhibition at the company's office on Liberty Street, this city, where it has attracted general attention from mineralogists and metallurgists. The nugget is not pure platinum, of course, as a pure nugget of the metal is rarely, if ever, found. The nugget contains not only a number of reguline ingredients, but a number of non-metallic species. It is expected that the nugget will yield about 60 per cent. of metallic platinum.

The London Times says: "At the annual meeting of the South American Missionary Society recently, a report was presented containing a letter from the bishop of the Falkland Islands on the state of Terra del Fuego. For several years the physical and moral improvement of the Indians under the influence of the mission was most encouraging. But in the wake of government came soldiers, sailors, traders and gold searchers, with the usual result. Finally an attack of measles followed a distribution of clothes by the Argentines. The civilized Indians living within a radius of thirty miles of the mission at Ushuwaia almost all died, and the future of that mission was hopeless."

Baltimore has a novel census of buildings conducted biennially by the police. The statistics deal with the occupied and vacant buildings, the water supply, etc. By the census just completed the city is shown to have 104,090 buildings, 85,936 of which are dwellings, 9,316 business houses, 400 churches, and 303 schools. The proportion of unoccupied dwellings is larger than it was two years ago, and the same is true as to stores and factories. In the two years there were additions of 1,737 dwellings, 49 educational buildings, 1337 business buildings, 2 churches, 245 stables, and 9 manufactories. The percentage of buildings unsupplied with water dropped from 8 in 1895 to about 6½ in 1897, but nearly 7,000 buildings are yet lacking this sanitary improvement.—N. Y. Evening Post.

The vexed question of the extermination of the Australian rabbit, which has hitherto constituted the chief problem that has confronted every antipodean administration, has at length received a satisfactory solution. There is no longer any necessity for invoking the services of great scientists such as the late Dr. Pasteur and Professor Koch to devise means for their extermination, for the invention of the cold storage rooms on board ships has led to the bunnies being exported in a refrigerated condition to the omnivorous market of the mother country. Rabbit pie is a favorite dish in the United Kingdom, and the rabbit which could not be successfully canned for transport and preservation is now leaving Australia for England at such a rate that soon there will not be a single one of them left in the antipodes.

A new process has been suggested for preventing rust on iron structures, which consists in treating the iron with a solution of ferrocyanide. This forms a coating of cyanide of iron, that is stated to be uniform and permeable, and of such a nature as to effectively protect the iron so covered. The solution is mixed with a flaxseed varnish, to which has been added a little turpentine or benzol, so as to cause a very homogeneous emulsion, which can be applied without difficulty. The evaporation of the alcohol leaves the flaxseed varnish, which forms a coat, and protects the cyanide of iron, which is deposited upon the metal. The iron requires no preparation for this treatment beyond removing any rust that may already have been formed, and which may be too thick to admit of the action of the ferrocyanide. Further details are lacking.

The human heart is practically a force pump about six inches in length and four inches in diameter. It beats 70 times per minute, 4,200 times per hour; 100,800 times per day, and 36,792,000 times per year; and 2,575,440,000—say two thousand five hundred and seventy-five millions four hundred and forty thousand—times in 70 years, which is "man's appointed three score years and ten." At each of these beats it forces 2½ ounces of blood through the system, 175 ounces per minute, 656¼ lb. per hour, or 7·03 tons per day. All the blood in the body, which is about 30 lb., passes through the heart every three minutes. This little organ pumps every day what is equal to lifting 122 tons one foot high, or one ton 122 feet high—that is, one ton to the top of a 40 yards mill chimney, or 16 persons seven score each to the same height. During the 70 years of a man's life this marvelous little pump, without a single moment's rest, night or day, discharges the enormous quantity of 178,850 tons of human blood.

The London Daily Financial News says: "Foreign matches, in future, instead of being supplied to us from Sweden, will apparently come all the way from Japan. The competition of the Orientals has already, it is said, destroyed the European match trade in India, China, and Hong Kong, and will soon assert itself in the United States. After supplying their home market the Japanese are able to send 2,500,000,000 boxes to the rest of the world, Asia, of course, taking most of this surplus output. Osaka, where an American syndicate has purchased one of the numerous factories engaged in the manufacture, produced last year 100,000,000 dozen boxes of matches, giving employment to 3,629 men and 9,711 women, besides thousands of children, who earn a few sen per day in the work. The sticks are cut by machinery, sifted into little boxes by women and collected and put in frames by the picayunes. The sulphur and paraffin are put on in hand presses, and the smeared points are then dried in the sun. The boxes and labels are made by little girls, who are extremely dexterous in the work. When it is mentioned that these little experts get from ½d. to 2½d. for twelve hours' work, or an average, perhaps, of about 6d. a week, all hope of Europeans matching the Japanese in this line must be given up."

THE BERLINER TELEPHONE AND TRANSMITTER PATENTS.

In another part of this number will be found the conclusion of the opinion of the United States Supreme Court sustaining the later Berliner patent. As a matter of interest we show reproductions of the drawings in both patents and reproduce the description of the inventor, with the claims of each patent, as follows:

ELECTRIC TELEPHONE.

Patent No. 233,969, dated November 2, 1880. Filed September 3, 1880. Issued to Emile Berliner.

My invention consists in a new and useful improvement in telephonic receivers for producing sound by means of varying electrical currents, of which the following is a specification.

It is a fact and a scientific principle that, if two electrodes be placed in contact to form part of a circuit and a current of electricity be passed through them, a repulsion is exerted between them. Based on this fact I have constructed a simple receiver for an electric telephone apparatus.

In Fig. 2 of the drawings, A is a metal plate well fastened to the wooden box or frame, but able to vibrate. Against the plate and touching it is the metal ball, c, terminating the rod, B, which rests on the bar or stand, d, and presses against the plate, which pressure, however, can be regulated by the thumb screw attached to the ball.

If a current of electricity passes through the plate and the point of contact, or vice versa, a repulsive movement will take place between the plate and the ball, because both are charged with the same kind of electricity. This force of repulsion may be weakened or strengthened by varying the strength of the current. As that strength is varied by any appropriate form of electric speaking telephone transmitter (especially that shown at A B of the various figures of the drawings, and more particularly described and claimed by me in another application filed June 4, 1877, of which this is a division), so will also the force of repulsion at the point in the receiver be alternately weakened and strengthened as many times accordingly, and will therefore cause its plate to vibrate at the same rate and measure. The latter vibrations being communicated to the surrounding air, the same kind of sound as uttered against the transmitter, Fig. 1, will be reproduced at the receiver, Fig. 2, or in as many other receiving instruments as are situated within the same electric circuit.

In Fig. 2 I have shown the receiver as consisting of a diaphragm in contact with a ball. In Figs. 3 and 4 I show it as somewhat differently mounted, and with the contact piece in the form of a pin instead of a ball, and in Fig. 6 in a still different form with a carbon contact. In this figure W is a piece of carbon.

In Fig. 5 two plates in contact at their edges are shown.

In the drawings, the letter A represents a diaphragm or plate, preferably of thin metal of limited conductive capacity, such as iron, steel, German silver, platinum, and also carbon secured in the frame, m m, in the box, f, in any convenient manner.

The letter y represents a ring resting against one side of said diaphragm, and capable of being made to bear upon the same with more or less force by means of set screws, n, in order that the tension of the diaphragm may be regulated.

The letter B represents a screw or piece of metal or carbon, pointed at one end and mounted in a cross piece, d, in such position that the point will be in contact with the diaphragm, A. The diaphragm, A, is connected with one pole of a battery by means of a wire, and the pin or screw, B, with the other pole.

Fig. 4 shows the manner in which the complete apparatus, consisting of the transmitter, A B, and the receiver, A B, is connected up in circuit.

It will be observed that the transmitter is of the same construction as the receiver. When a sound is uttered in the neighborhood of the transmitter its plate will vibrate accordingly, and the pressure between the plate and the pin or ball at the point of contact, a, will become weaker or stronger, according to the vibrations, and this variation of pressure will cause the current passing to become weaker or stronger, and thus effect the changes which operate the receiver, as already described.

As shown in Fig. 3, the box, f, is provided with a tube, K, to which the ear of the operator may be applied in order to hear the sounds produced by the vibratory diaphragm when the instrument is employed as a receiver, and a tube, O, through which he can speak when employing the instrument as a transmitter, so that the operator is not in need of moving the instrument or moving his head while carrying on a conversation. This combination, with the sound chamber of a telephone provided with the usual sound passage or mouth piece, of an additional sound conveyer or hearing tube forms, however, no part of the invention.

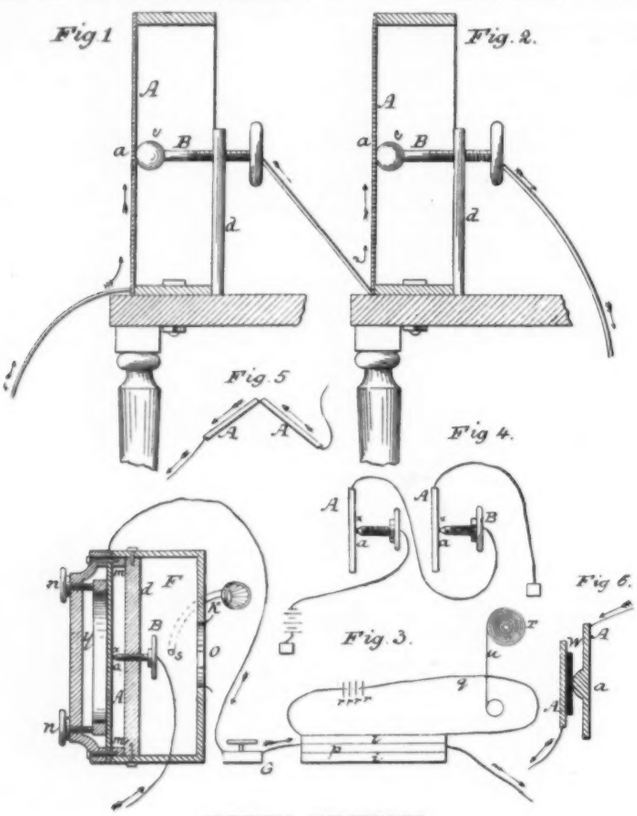
I claim—

1. The herein-described method of producing sound vibrations in a plate by causing a varying electric current to pass to the plate, or to an electrode connected therewith, from a second electrode in contact therewith, substantially as described.

2. An apparatus for producing sound by means of a varying electric current, which consists of a plate forming or carrying an electrode placed in contact with another electrode, from one to the other of which the electric current is caused to pass.

3. An electric telephone receiver to be operated by varying electric currents, and consisting of two contact pieces within an electric circuit, one or both of which pieces consist of or are connected with a vibratory diaphragm, whereby one electric current passing through said circuit exercises a repulsion between said two electrodes corresponding to its strength, and thus produces corresponding motions in the diaphragm.

4. A system of two or more telephone instruments in electrical connection with each other, each consisting of two or more poles of an electrical circuit in contact one with the other, either or both poles of each instrument being connected with a vibratory plate, so that any vibration which is made at one contact is reproduced at the other, substantially as set forth.



ELECTRIC TELEPHONE.

E. Berliner Patent No. 233,969, November 2, 1880.

COMBINED TELEGRAPH AND TELEPHONE.

Patent No. 463,569, dated November 17, 1891. Filed June 4, 1877. Issued to Emile Berliner.

My invention consists in a new and useful improvement in transmitters for electrically transmitting sound of any kind, of which the following is a specification.

It is a fact that if at a point of contact between two conductors forming part of an electric circuit and carrying an electric current the pressure between both sides of the contact becomes weakened, the current passing becomes less intense—as, for instance, if an operator on a Morse instrument does not press down the key with a certain firmness the sounder at the receiving instrument works much weaker than if the full pressure of the hand had been used. Based on this fact I have constructed a simple apparatus for transmitting sound along a line of an electric current in the following manner.

In Figs. 1 and 2 of the drawings, A is a metal plate well fastened to the wooden box or frame, but able to vibrate if sound is uttered against it or in the neighborhood of said plate. Against the plate and touching it is the metal ball, C, terminating the screw threaded rod, B, which is supported by the bar or stand, d. The pressure of the ball, C, against the plate, A, can be regulated by turning the rod, B. The said ball and plate are included in circuit with an electric battery, so that they form electrodes, the current passing from one of them to the other. By making the plate vibrate, the pressure at the point of contact, a, becomes weaker or stronger as often as vibrations occur, and the strength of the current is thereby varied accordingly, as already described. By placing now, as is shown in the drawings, one such instrument in the station, Fig. 1, and another instrument capable of acting as a telephonic receiver in the station, Fig. 2, both situated on the same electric circuit in which a current is passing (as shown by the wire connections following the arrows), sound uttered against the plate of the instrument, Fig. 1, will be reproduced by the plate of the instrument, Fig. 2, for as the vibrations of the transmitter, Fig. 1, caused by the sound will alternately weaken and strengthen the current as many times as vibrations occur, the diaphragm of the receiver will be caused by these electrical variations to vibrate at the same rate and measure. The latter vibrations being communicated to the surrounding air, the same kind of sound as uttered against the transmitter, Fig. 1, will be reproduced at the receiver, Fig. 2, or in as many other receiving instruments as are situated within the same electric circuit.

It is not essential that the plate should be of metal. It can be of any material able to vibrate, if only at the point of contact suitable arrangement is made so that the current passes through that point. The plate may be of any shape or size, or other suitable vibratory media may be used—a wire, for example. Any other metallic point, surface, wire, etc., may be substituted for the ball. There may be more than one point of contact to be affected by the same vibrations. Both of the electrodes may vibrate, although it is preferable that only one should. If the uttered sound is so strong that its vibrations will cause a breaking of the current at the point of contact in the transmitter, then the result at the receiving instrument will be a tone much louder, but not as distinct in regard to articulation.

I have also embodied my invention in and used it in connection with some other forms of apparatus.

In the drawings, Fig. 4 represents a detached view of the vibratory diaphragm, showing its relative situation to the poles of the galvanic current. Fig. 3 represents a view of a complete apparatus. Fig. 5, a view of the diaphragms arranged to receive and transmit the sound waves, and Figs. 6, 7 and 8 modifications of the vibratory diaphragm.

In the drawings, the letter A represents a diaphragm or plate of thin metal of limited conductive capacity, such as iron, steel, German silver, platinum, secured in the frame, m, m, in the box, F, in any convenient manner.

The letter y represents a ring resting against one side of said diaphragm, and capable of being made to bear upon the same with more or less force by means of set screws, n, in order that the tension of the diaphragm may be regulated.

The letter B represents a screw or pin of metal, pointed at one end and mounted in a cross piece, d, in such position that the point will be in contact with the diaphragm, A. The diaphragm, A, is connected with one pole of a battery by means of a wire, a', and the pin or screw, B, with the other pole by means of a wire, b'.

The box, F, of Fig. 3 is provided with a tube, K, to which the ear of the operator may be applied in order to hear the sounds produced by the vibratory diaphragm when the instrument is employed as a receiver, and a tube, O, through which he can speak when employing the instrument as a transmitter, so that the operator is not in need of moving the instrument or moving his head while carrying on a conversation.

Instead of employing a single vibratory plate, as shown in Figs. 1, 2, 3, 4 and 5, in each instrument, two such plates may be employed, as illustrated in Fig. 8, said diaphragms being connected to the respective poles and in contact with each other at their edges as shown in Fig. 8.

The diaphragm of my improved receiver or the diaphragm of any magneto-receiver (such as those described by Alexander Graham Bell in his patent, No. 174,465, of March 7, 1876, and in his patent, No. 186,787, of January 30, 1877) will receive a particularly strong shock at the setting in and sudden cessation of the current, when a ticking sound will be heard from the plate; but a weakening of the current alone can also be observed most distinctly and accurately by making, for example, a connection within the same circuit by a wire and the blade of a knife, k, Fig. 4. When scraping the wire end over the blade of the knife, this scraping is distinctly audible on the plate. Here the current is never entirely interrupted, yet the minute elevations and cavities on the blade, caused by the structure of the steel, and which again cause minute alterations in the intensity of the current, are sufficient to shake or vibrate the plate with varying intensity, thus rendering again the same peculiar scraping noise. If, now, the plate of one instrument, as in Figs. 1 or 5, is vibrated by sound waves (which happens whenever any kind of sound is uttered or is produced by musical instruments in its neighborhood), every wave or vibration that strikes the plate produces between the two sides of the contact a variation of pressure, which causes a variation of resistance at that point, and, therefore, a variation in the strength of the passing current, and if the sound is sufficiently strong it will break the circuit at said point of contact, the variations in the current thus produced causing similar vibrations in the plate of the receiving instrument.

The essential part of the apparatus is the point of contact, which must offer a resistance to the current.

It is not necessary in the transmitting apparatus that the plate should be of conducting material, for any substance capable of vibration will answer, if only at the point of contact provision is made for the current to pass. It is sometimes convenient to use a vibrating plate in the form of a reflector, as shown in Fig. 6, for concentrating the sound, or the diaphragm may be provided with a number of apertures to disperse the sound, as shown in Fig. 7. These apertures prove advantageous with strong sounds, particularly the hissing sounds, as, while the sound waves are rushing toward the diaphragm, those touching the plate are repelled and partially destroy the following waves, just as sea waves when forced against a cliff will be thrown back, destroying those directly behind. The holes permit most of the waves to pass to the other side of the plate, making the vibration of the plate more perfect and even.

I will here describe a recording apparatus, which, however, I do not claim.

In Fig. 3, G is a galvanometer which is located in circuit with the contact pieces or electrodes, A B, and which serves as a convenient means for ascertaining the adjustment of the contact pieces of the transmitter so that a current shall pass. i, p, i is a Ruhmkorff coil or induction apparatus. When a current passes through the primary coil, p, and suddenly is broken a spark will rush over between the ends of the secondary coil, i, i, at q. This spark is accompanied by a peculiar sound due to the electric discharge, and if we bring between the ends of the secondary the connecting points, r, r, r, r, a spark will occur between each of them, provided they are near enough to each other, and the peculiar sound will be heard between each of them. I now arrange a strip of chemically prepared paper or other substance, n, to be drawn by clock work, T, between the ends of this secondary wire at q. Said strip can be prepared in such a way that each spark will produce a mark upon it. If, therefore, the plate, A, vibrates by sound, each vibratfon causing a break of contact will produce a spark at q, and the strip being drawn through, a succession of marks will be produced upon the strip according to the number of vibrations caused by the sound; but at the same time the sound which was uttered at the plate, A, will be heard from the sparks rushing over the points, r, r, r, r, and q, because every spark produces one wave in the atmosphere in which it occurs, and a certain number of waves will therefore produce certain tones. Therefore the same sound which is uttered against the plate, A, will be heard from the sparks. The scraping of the wire end on the knife blade, k, as in Fig. 4, in the primary current will also be heard between the wire ends of the secondary current at r, r, r, r, and q. This permits a number of designs for a receiving apparatus within the secondary current. For instance, initials, ornaments, etc., consisting of a number of metal pins, can be constructed in such a way that whenever a tone is produced against the plate, A, a spark will rush over said metal pins, and at the same time their sound is produced will render the design visible in illuminated characters.

By making the person of the operator a part of the secondary circuit and discharging the sparks in the body in the neighborhood of the ear the sound will be more particularly apparent.

It will be observed that in Figs. 1 and 2 one of the electrodes presents a convex curvilinear surface like a rounded knob. This possesses some advantages, among which are ease of construction and durability, because it does not wear away the opposing electrode as much as a sharp one would, and when the contact with the vibrating body is made of such a form, the freedom of the vibration is less interfered with.

I do not claim that I am the first inventor of the art of transmitting vocal and other sounds telegraphically by causing electrical undulations similar in form to the sound waves accompanying said sounds. Neither do I claim that I am the first who caused such electrical undulations by varying the resistance of an electric circuit in which a current was passing.

I do not herein claim the novel form of vibratory plate receiver which I have described, because that is a subject of claim in another application.

I claim—

1. The method of producing in a circuit electrical undulations similar in form to sound waves by causing the sound waves to vary the pressure between electrodes in constant contact so as to strengthen and weaken the contact and thereby increase and diminish the resistance of the circuit, substantially as described.

2. An electric speaking telephone transmitter operated by sound waves and consisting of a plate sensitive to said sound waves, electrodes in constant contact with each other and forming part of a circuit which includes a battery or other source of electric energy and adapted to increase and decrease the resistance of the electric circuit by the variation in pressure between them caused by the vibrational movement of said sensitive plate.

3. The combination, with the diaphragm and vibratory electrode, of a rigidly held opposing electrode in constant contact with the vibratory electrode, substantially as described.

4. In a telephonic transmitter, a vibrational plate made concave for condensing the sound, substantially as set forth.

5. In a telephonic transmitter, a vibrational plate provided with one or more apertures, as and for the purposes set forth.

6. A speaking telephone transmitter comprising a diaphragm or disk sensitive to sound waves, combined with a rigidly held but adjustable electrode in contact with the same, whereby the electric current is transformed into a series of undulations corresponding with the vibrations of said diaphragm.

The patent No. 233,969, of November 2, 1880, expires November 2, 1897.

Judge Carpenter, of the United States Court at Boston, Mass., in considering the identity of the two inventions, said, on December 18, 1894, in his decision:

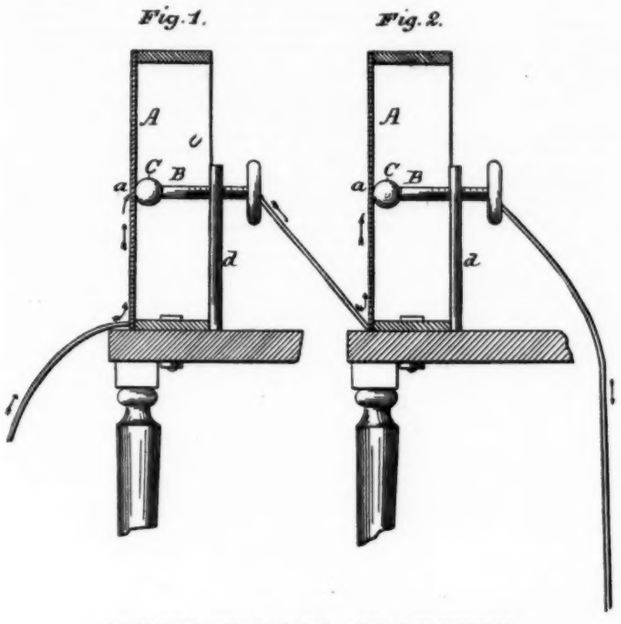
"The first ground of the bill to which I shall refer is that the patent is void as being beyond the power of the commissioner to issue, in view of the issue of a former patent, No. 233,969, issued November 2, 1880, to Emile Berliner, for an electric telephone.

"The patent of 1891 is for a transmitter for a speaking telephone. The fourth claim of the patent of 1880 is as follows:

"4. A system of two or more telephone instruments in electrical connection with each other, each consisting of two or more poles of an electrical circuit in contact one with the other, either or both poles of each instrument being connected with a vibratory plate, so that any vibration which is made at one contact is reproduced at the other, substantially as set forth.

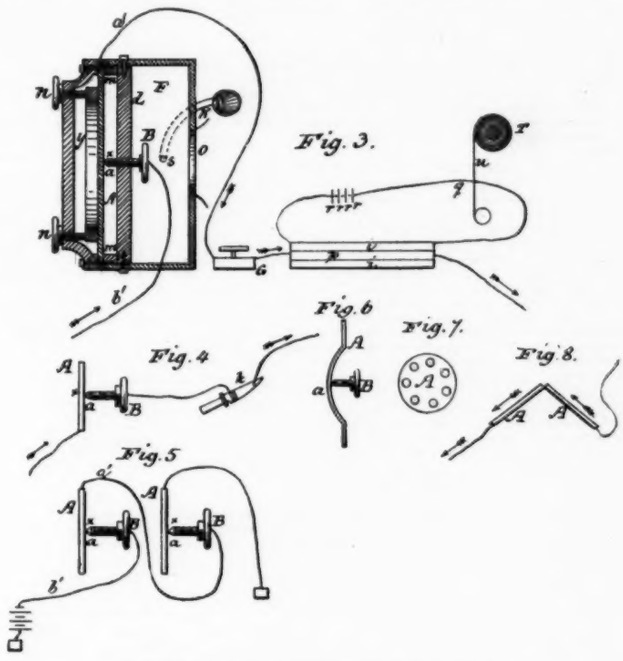
"This patent is, therefore, for the 'system' of combination of a transmitter and a receiver for a speaking telephone. The whole apparatus is shown in the drawings of both patents and is identically the same in both. The transmitter and receiver are identical in form and differ in function according as they are placed at the transmitting or at the receiving end of the telephone wire. It therefore appears that one of the functions of the device shown in the patent of 1880—namely, the function of transmitting articulate speech—is identical with the sole object or function of the device covered by the patent of 1891, and that the device for effecting the transmission is identical in both patents.

"The patent therefore seems to me to be void and beyond the power of the commissioner to issue. (Miller v. Eagle Manufacturing Company; ante, 147; 66 O. G., 845; 151 U. S., 186.)"



COMBINED TELEGRAPH AND TELEPHONE.

E. Berliner Patent No. 463,569, November 17, 1891.



COMBINED TELEGRAPH AND TELEPHONE.

Copy of Sheet II, E. Berliner Patent No. 463,569.

ELECTRICITY VERSUS SHAFTING IN THE MACHINE SHOP.*

By CHARLES H. BENJAMIN, Cleveland, O.

THE trend of the discussion of a paper entitled "Friction Horse Power in Factories," presented at the December meeting of the society, has suggested the presentation of this paper.

It seemed to be the opinion of many of the members who took part in that discussion that the best solution of the problem was to "take the bull by the horns" and throw him out of the arena altogether; in other words, to displace shafting and belts by electric transmission rather than to try to improve their efficiency. That in many cases this is the true solution can scarcely be doubted; but it seems to the writer that there are considerations of more importance than mere economy of transmission.

In order to put this in concrete form, twelve establishments mentioned in the previous paper have been selected, the numbers from one to six inclusive representing establishments using heavy machinery, and the numbers from seven to twelve representing light machinery establishments.

In Table I the data are taken from the preceding paper, while the results in Table II are calculated.

The cost of the shafting in column 1 of Table II includes the cost of probable hangers, couplings, and pulleys, and is based on the actual price of similar shafting in a modern shop, the cost ranging from $2 to $6 per linear foot.

The cost of the belting assumes the belts to have been from 30 to 50 feet long, and of single leather, and varies from $6 to $27 per belt for the widths given.

It is not claimed that the figures given in this column represent the exact cost of shafting and belting, but they show what the cost might well be in such establishments.

In estimating the cost of generators and motors for these same shops, it is assumed that a generator will be required having a power 50 per cent. greater than the net power used by the machines when the shop is running at full capacity, and that the aggregate power of the motors should be double this. It is further assumed that the motor unit will be from 5 to 10 horse power in the shops doing heavy work, and not less than 2 horse power in the shops doing light work. The cost of electric motors may be roughly classified as follows:

Horse power of motor.	2	3	5	10	20	40	50	65	75
Cost in dollars per H. P.	65	60	45	35	25	20	17	16	15

The figures in column 2 of Table II thus show what might reasonably be expected as to the cost of generators and motors for each establishment. No account has been made in the one case of the cost of countershafts and secondary belting, nor in the other of conductors, switches, and such countershafts as might be used, one omission being allowed to offset the other.

Column 3 shows the differences between the values in the two preceding columns, the + sign indicating greater first cost for electricity, and the — sign greater first cost for shafting transmission. It will be noticed that in general the electrical transmission has the greater first cost, but in establishments where the amount of shafting is out of all proportion to the useful work done, electricity has the advantage even here. (See shop No. 4.) In shops like Nos. 10 and 12 the machinery is compactly arranged and the cost of shafting relatively light.

If there is any unfairness in the above figures, it is in overestimating the electrical cost, since the writer desires to be conservative.

The figures in column 4 of Table II are derived from those in column 8 of Table I, by assuming a combined efficiency of two-thirds for generators and motors. The power lost in shafting transmission, column 5 of Table

* Presented at the Hartford meeting (May, 1897) of the American Society of Mechanical Engineers.

TABLE I.

Number	1 Total Line Shaft in Feet	2 Diameters of Line Shafts Inches	3 Number of Belts	4 Average Width of Belt	5 Number of Machines	6 Number of Men	7 Total Horse Power	8 Horse Power to Drive Machinery	9 Horse Power to Drive Shafting	10 Useful Horse Power per Machine
1	1,180	2¾ 2½	89	4	.....	.....	409	243	157	.....
2	380	3 2¾ 4 3½	28	6	18	28	74	17	57	.....
3	530	3¼ 3	58	5½	48	155	98.6	13.8	23.8	210
4	1,400	2¾ 3 4	92	4½	69	81	59.2	11.3	47.9	164
5	1,120	2 3 4	141	4	68	200	112	40	64	707
6	1,085	2 3 4	100	4	103	215	169	77	91	627
7	748	1¾ 2½ 3	217	3	230	260	40.4	19.7	20.7	790
8	500	2 3	325	3	315	226	74.3	34.3	40	109
9	980	1¾ 2½	217	3	208	100	47.3	24.7	24.5	881
10	2,400	2 3	521	3	451	400	180	82	108	180
11	1,472	2 3 4	464	3	179	350	107	32.5	74.5	181
12	1,800	2 2¾ 3	466	3	438	320	241	127	114	296

TABLE II.

Number	1 First Cost of Shafting and Belting	2 First Cost of Electrical Motors	3 Difference in First Cost	4 Horse Power per Hour Lost in Shafting and Belting	5 Horse Power per Hour Lost in Motors and Wiring	6 Net Saving by Electric Motors Horse Power	7 Saving in Coal per Year	8 Pay Roll per Year at $417 Saving
1	.....	.....	.....	121	117	No gain.	.....	.....
2	6,650	7,150	+ 500	9	49	40	2,400	30,000
3	3,750	3,000	− 750	7	21	14	840	76,000
4	7,450	2,100	− 5,350	6	43	36	2,160	40,000
5	7,700	7,000	− 700	24	53	29	1,740	150,000
6	8,550	10,950	+ 2,400	29	74	45	2,160	112,500
7	2,700	4,300	+ 1,600	10	16	6	360	100,000
8	4,000	7,000	+ 3,000	17	32	15	900	113,000
9	4,000	5,000	+ 1,000	12	20	8	480	50,000
10	9,650	18,000	+ 8,350	41	89	48	2,880	200,000
11	7,550	7,000	− 550	16	64	48	2,880	175,000
12	8,400	25,000	+ 16,600	64	90	26	1,560	160,000

II, is obtained from column 9 of Table I, by deducting ten per cent. of gross horse power for engine friction.

The net gain in horse power by using electric transmission is shown in column 6. Allowing $60 per horse power per year as the gross cost of power delivered, we obtain the results in column 7 for the saving in dollars per year.

Some one may object that these calculations are rough, and based on insufficient data. Even if we admit this, two facts can still be regarded as proved:

1. That the first cost of electrical machinery is usually greater than that of shafting and belting.

2. That the saving in power in most machinery establishments would pay for the additional cost of the electric plant in from one to five years.

Figures of this kind are about all that we can have to guide us at present. Statements from manufacturers are liable to be influenced by a personal bias one way or the other; and even where there is an opportunity for a fair comparison, the necessary data are usually lacking. Many cases could be cited where parties now using electricity claim an actual saving in coal burned of from 15 to 30 per cent.

In most establishments where electricity has been introduced, the transition has only been partial, the generator and motors being burdened with a load of shafting and belts which prevent any saving in power from being effected. It is in new shops constructed with especial reference to electric transmission that we are to look for the best results in efficiency.

It is further to be remembered that the loss of power from shafting and belts is constant as long as the engine is running, whether one machine or a hundred be in operation, while the loss in electric transmission is a per cent. of the actual power used, and diminishes as the consumption of current diminishes. This is particularly important during times of business depression, when only a part of the plant is in operation.

Some space has been devoted to considering the question of relative first cost and efficiency, since many arguments pro and con have hinged on these two points.

Electricity should not base its claims to recognition on either of these. In most cases there are far more important advantages to be considered. Referring again to Table II, it will be noticed that in column 8 are given the estimated pay rolls of the different establishments, allowing $500 per annum for each man employed. Notice how large these numbers appear in contrast with those we have been considering. A saving of from two to five per cent. in the pay roll is of more importance than any saving that is likely to be effected in the power plant.

The average useful horse power per man in the heavy machinery establishments before mentioned was 0·38 horse power, representing $22.80 per year on the usual estimate of $60 per horse power per year. If the services of the man are set at $500 per year, a low figure, the average cost of power is only 4½ per cent. of the cost of labor.

In the light machinery establishments the average useful horse power per man was only 0·195 or $11.70 per year; being only 2¼ per cent. of the labor cost.

In some shops the power cost represents only about one per cent. of the total expense of running.

The question of the advantage of introducing electricity hinges not upon efficiency of transmission, but upon the effect on the output of product per man and per machine.

The different points to be considered in determining how electricity affects general economy of production may be classified as follows:

1. General arrangement of machinery to facilitate handling of work.
2. Clear head room for the use of electric cranes and small hoists.
3. Light and cleanliness.
4. Control of speed.
5. General flexibility of the system.
6. Use of electricity for other purposes than power.

1. GENERAL ARRANGEMENT.

The ordinary machine shop of to-day, in its shape and size and in the general arrangement of its engines and machinery, is the slave of shafting transmission. The engine must be so located as to connect conveniently with the shafting; all the machines must be arranged in parallel lines, for the same reason; while the ceilings and posts must be designed with special reference to the demands of hangers and brackets. This has been so long the case that perhaps we hardly realize the possibility of a change.

Machinery should be arranged with reference to the work it is to do, and not with reference to the power to be used; it should be so located on the floor of the shop as to be easily accessible for operation and attendance, and in such a way that the work may be readily handled and well lighted.

The whole shop should be planned with a view to handling the product with the least waste of time and labor, and electricity makes this possible. Large machines may be put in any position and at any angle, or, if need be, may be transported from place to place to accommodate the work. The power plant may be located in the most favorable place for taking care of coal, water and ashes, and the power distributed to any building or buildings, with but little loss.

2. CLEAR HEAD ROOM.

In all shops doing heavy work the rapid and economical handling of the work is one of the most important factors in cheap production.

The electric crane is the most convenient and efficient carrier yet developed, and the absence of overhead shafting and belts in electric transmission makes its use possible over all the larger machines. The writer believes that small electric hoists will also take the place of hand hoists over smaller machines, until every machine in the shop can be reached in this way when desired.

This advantage of the electric system was what prompted its introduction into the Baldwin Locomotive Works, and the saving there has been notable. Formerly from 30 to 40 laborers were employed to handle the work in the wheel shop, while now only 8 or 10 are needed; formerly from 8 to 10 per cent. of the time of the skilled help was lost from delays in handling, but this loss has been reduced to less than two per cent. A saving of this kind is of more importance than any probable saving of coal.

3. LIGHT AND CLEANLINESS.

As another result of our long subjection to ordinary methods of conveying power, we have come to regard a machine shop as necessarily dark, a synonym for all that is black and dingy. A glance at the shops of some of our electrical establishments will convince any one that this is a mistake.

Shops like those of the Crocker-Wheeler Company, the Westinghouse Company, etc., have been called "show places;" but at least they show the way from darkness into light, and should receive credit for it.

The belt is a dust carrier as well as a power carrier, and nothing can be kept clean in its vicinity. When we add to this the shadows cast by the shafts and belts themselves, we have a condition of things which tends to mistakes and poor work, and cannot be without a corresponding moral effect on the workman.

The writer saw, during the winter holidays, in one large establishment having the usual maze of countershafts and belts, an attempt to whitewash ceilings and walls, which was almost pathetic in its absurdity.

The partial or entire absence of overhead belts, and the diffused light reflected from whitewashed ceilings and walls, will cause an improvement in both quantity and quality of output which will prove a strong argument for electricity.

4. CONTROL OF SPEED.

One of the minor advantages of direct connected motors on large machines is the possibility of easily and quickly adapting the speed of the machine to the kind of work being done. On large boring mills and lathes, especially when facing up work, this may be a factor of considerable importance in determining the cost of production.*

5. GENERAL FLEXIBILITY OF THE SYSTEM.

The ease with which the electric system of transmission may be adapted or extended is one of the strongest arguments in its favor. The extravagant consumption of power, as noted in the former paper, is probably due, in most cases, to a gradual extension of the shafting system by lengthening shafts beyond a reasonable limit, to the turning of corners with bevel gears, and to the use of turned and twisted belts, with their attendant evils in the way of guide pulleys.

Shops are usually planned with a view to present needs rather than future possibilities, and extensions are made at some disadvantage; but in the electrical shop this need cause no uneasiness. Whatever the location or the angular position of the new building, the only expense is that of new motors and a few hundred feet of wire.

If added experience shows the desirability of rearranging any part of the original plant, there is nothing in the way. If at any time the mountain declines to go to Mahomet, Mahomet can easily be moved to the mountain, in the clutches of an electric crane.

6. OTHER USES OF THE ELECTRIC CURRENT.

If the right kind of an electric system be chosen, the same current can be used in a variety of ways which are just beginning to be appreciated. Besides the advantage of having arc and incandescent lamps without any additional expense for generators, the electric current may be used for welding, brazing, soldering, annealing, and case hardening, and each and all of these operations may be effected locally on large machines without moving them from their positions.

Some are inclined to look askance on electric motors, and to have doubts as to their durability and freedom from accident. To the ordinary manufacturer and superintendent the electric motor is something that he does not fully understand, and, consequently, something to be distrusted.

An electric motor, if properly designed and constructed, requires no more care than any piece of machinery running at the same speed. The writer has had under his personal observation motors which have run for years whenever called on, have required less care than an ordinary loose pulley, and have cost almost nothing for repairs.

Only lately the writer saw a railway motor driving a grinder for pulverizing furnace linings, in an atmosphere so full of grit and dust that the operator had to keep his mouth and nose masked. The motor under a street car will convince the most superficial observer that there is nothing to be feared on this score.

It is difficult to get reliable and precise data from actual examples, even from establishments where both kinds of transmission have been tried; but the almost universal testimony of such is that the new experiment is a success, that they would not go back to the old system, and that as rapidly as possible the electric system will be extended to all parts of the works.

The writer has recently visited several establishments in Cleveland where electricity has been introduced to a greater or less extent.

The works referred to as No. 5 in the preceding tables have, within the past year, been partially equipped. An electric plant has been put in, consisting of a 150 kilowatt generator, belted from the engine, and furnishing a direct current of 220 volts to various motors and to arc and incandescent lamps throughout the buildings. The motors are mostly shunt wound, self-regulating, and vary in capacity from three to fifteen horse power.

Owing to the arrangement of the buildings, it had formerly been necessary to run line shafts at right angles, and use quarter turn belts and guide pulleys. Some of the motors are now used at the angles to do away with the belts, but in general the shafting itself has not been disturbed, and consequently much of the loss due to shafting transmission remains.

In other instances independent motors are used to drive large machines, or groups of machines. When there is much dust, as in the case of emery grinding, the iron clad motor is used. Although this can be called but a partial trial of the electric system, and has many of the disadvantages which could be avoided in a new installation, the experiment is so far a success, and will be extended as fast as practicable.

Through the courtesy of Mr. Bartol, a member of the society, and superintendent for the Otis Steel Company of Cleveland, the writer was permitted to inspect the works of the company, where a new electric plant is being installed. The company have used electricity to a limited extent for some time, and the present installation is intended to concentrate and unify the plant. As the works are distributed over an area of about fifteen acres, and as the work is nearly all of a heavy nature, the wisdom of the change is apparent.

The central plant will contain a 165 kilowatt generator direct connected to a compound condensing engine, and a 75 kilowatt generator belted from a simple condensing engine, both generators furnishing current to the same circuit.

Either or both of the generators can be used, according to the amount of current needed. A direct current of 220 volts will be used for both light and power, the arc lamps being in series of four and the incandescent lamps in series of two. A central distributing tower is erected over the generator, from which overhead wires radiate to all parts of the works. Separate wires are run for the lighting system, in order that the lights may be controlled from the central station. Ammeters on each line show the relative amounts of current taken by each shop and by the lighting system. The switch board is also provided with those very important safety valves, automatic circuit breakers. Mr. Bartol determined the amount of current which would be needed in the different shops by a method which is to be recommended to all who anticipate such a change.

Indicator cards were taken from the engines when driving the shafting, and when driving the different machines, and the different shops, and from these cards the necessary capacity of motors and of generators could be quite accurately calculated.

The motors are either shunt or series wound, according to the use which is to be made of them, and vary in capacity from five to thirty horse power. The motors are in all cases belted to the machines or shafting and controlled by rheostats.

As a rule, no attempt has been made to displace shafting already in place, but the writer noticed two large roll turning lathes driven by independent motors, one of five and one of ten horse power.

In the finishing room for steel castings, the machines are all arranged along the side of the room and driven by counters and line shafting attached to the wall, leaving clear head room for the electric crane used in handling the work.

Electric cranes, both of the traveling and jib type, are in evidence throughout the works, and some portable machine tools are driven by independent motors. It is interesting to note that at this establishment the rival giants electricity, compressed air, and hydraulic power are working side by side, each in its own proper sphere.

At the new shops of the Atlas Bolt and Screw Company, of Cleveland, a two phase electrical plant has lately been installed. The buildings in this case are located on three sides of a triangle, with the power house at one angle, a situation of things which almost precludes the use of shafting in the ordinary way. To the electric wires this makes no difference.

The machinery is mostly of the automatic type arranged in groups, and running at a constant speed, a condition of things favorable to the polyphase system.

A sixty horse power high speed engine is belted to a 45 kilowatt two phase generator and to a 15 kilowatt exciter. The exciter is made of this size in order to furnish a direct current for the lighting as well, the lamp system being thus entirely distinct from the power system. This use of the exciter is somewhat novel and interesting.

Motors are scattered throughout the works wherever needed in sizes varying from five to twenty horse power. They are in most cases hung from the ceiling at the same height as the shafting, so that the belts are horizontal. The motors are all of the induction type and entirely destitute of commutators or brushes, so that they require no attention, except to keep the bearings oiled. The motors can all be started at once from the engine room, or each one separately by a switch.

No attempt has been made to do away with the line shafts and counters, as the nature of the machinery renders this impracticable, but the ability to run even remote sections of the shops independently of the re-

* See article by Mr. W. E. Hall, in Cassier's Magazine for February, 1895.

mainder, as well as the entire absence of vertical belts through the floors, has been sufficient reason for the adoption of this form of transmission.

GENERAL CONCLUSIONS.

When the shops of a manufacturing establishment are scattered over a considerable extent of territory, the installation of a central power plant having large and economical engines and the distribution of the power to the different shops by wires, instead of by steam pipes, is a change always to be recommended, and that will soon pay for itself.

When the establishment consists of one large building or compact group of buildings, a change to the electric system is to be recommended where heavy work is to be handled, especially if the machines are somewhat scattered, require considerable power, or are intermittent in their action. In such cases some of the shafting may be left in position, but the writer believes that the more independent motors are used on machines requiring over two horse power, the greater will be the economy.

In shops doing light work and having many small machines compactly arranged and in continuous operation, a change to the electric system would be expensive and of doubtful utility. See, for instance, shops Nos. 10 and 12 in tables.

In building a new shop the chances are better for electric installation; and any manufacturer who does not, under these circumstances, investigate the subject and consider carefully the question of using electricity, is making a great mistake.

The ideal arrangement for a shop handling heavy work is that of a building having one lofty center aisle lighted from above and two side aisles of less dimensions lighted from the sides. Every square foot of floor space in the central aisle should be commanded by electric cranes. Here the larger tools will be located, each with special reference to convenience in handling work, and, as far as practical, fitted with independent motors.

The smaller machines are located in the side aisles near the dividing line of columns, and may be driven in groups by short lines of shafting hung on the columns below the tracks of the traveling cranes, each line being driven by a separate motor.

Units of about five horse power are large enough for this kind of work.

Motors of two or possibly of one horse power are as small as can at present be economically used.

The benches for hand work should be located at the side walls near the windows. Smaller cranes and electric hoists may command all the space in the side aisles.

Some of the drills and shapers should be fitted with direct connected motors and have eye bolts at the top by which they may be moved from place to place.

In the power house the use of two generators, one large and one small, will often prove economical, the smaller one being used for night or overtime work.

POLYPHASE AND CONTINUOUS CURRENT SYSTEMS.

The writer, as a mechanical and not an electrical engineer, hesitates to say much on this delicate subject. However, it is a question which must be settled at the outset in deciding upon the arrangement of a shop.

The great advantages of the polyphase or induction motors are in their simplicity, their freedom from rubbing contacts and the constancy of their speed; the great disadvantage, the fact that the speed cannot be regulated, since the motor must always be in phase with the generator.

When electricity is to be applied simply to run line shafting and counters, and the speed of separate machines is to be controlled by the usual belts and gears, the polyphase system is entirely satisfactory.

On the other hand, when it is necessary to use independent and direct connected motors on cranes and on machine tools, prompt and economical speed control is an absolute necessity; and it is here that the continuous current machine has a great advantage. Without any prejudice, it is the earnest belief of the writer that the greatest advantages in electrical transmission are to come from the use of independent motors to the largest extent possible, and that the time will come when nearly every machine in the shop will have its own motor. Progress in this direction is slow, and the intermediate steps must be taken first; but when an electrician sneers at the use of direct connected motors per se, one cannot but suspect that it is only because he has not yet perfected a motor that will satisfy the requirements.

The principal difficulty in designing direct connected motors for machine tools has been that of getting slow speed without great weight and of securing proper speed variation without seriously impairing the efficiency. The multipolar machine has helped to solve the former difficulty. In regard to the latter problem it may be said that the speed of the motor has usually been changed by introducing resistance into the armature circuit, thereby causing a loss of power corresponding to the reduction of speed.

Lately motors have been constructed with so-called commutating fields. The motor in this case has several fields wound in separate coils, and when a change in speed is desired, these fields may be cut out one after the other.

If desired, a combination of this system with a resistance in the armature circuit may be used. The so-called Leonard system, having several feed wires carrying currents of different voltages, is, of course, somewhat expensive on account of the amount of copper used and the general complication of the system.

It is, however, very encouraging to note the improvements which are constantly being made in the construction of slow speed generators for direct connection.

It is better in a paper of this kind to avoid mention of any particular firms. Suffice it to say that there are at the present time at least two firms of established reputation who are ready to supply slow speed motors suitable for direct connection to machine tools and capable of almost any degree of speed regulation.

These motors can be run at from 100 to 200 revolutions per minute and can be obtained in sizes of from one to five horse power, while the guaranteed efficiency is from 70 to 80 per cent.

Until it shall be possible to do away with shafting and belts in situations where that is desirable, the problem is only partially solved.

The steps thus far taken in the direction of electrical transmission, while encouraging, can only be regarded as the beginning of a more radical change.

It is the hope of the writer before another year to make some experiments in establishments which have introduced electrical transmission, and to show more conclusively than has been done in this paper the economic advantages of the newer system.

[Continued from SUPPLEMENT, No. 1117, page 17854.]

THE BERLINER TRANSMITTER PATENT.*

ANOTHER matter referred to by counsel is what they call the "tacit understanding." The facts are these: One Daniel Drawbaugh claimed to have invented the telephone prior to Bell. He assigned his inventions to the People's Telephone Company, between whom and the defendant company a heated and protracted litigation arose. Now, it is said that there was an agreement, or, at least, a tacit understanding, between the officials of the Patent Office, the People's Company and the defendant company that the proceedings in the Patent Office in respect to the Berliner application should wait the determination of the litigation between the two telephone companies. It is insisted that the officials had no right to enter into such an agreement; that it was unlawful in its character. Assuming that this is so, still the fact appears that the proposition therefor came from the representatives of the Drawbaugh interest, that it was deemed by the officers of the Patent Office to be for the best interests of all, and that it was simply assented to by the defendant. Nowhere does it appear that the defendant urged, or even suggested, the propriety of such a delay. For the present we do not consider the wisdom or the rightfulness of the course pursued. All that we desire to notice is that it was not at the instance of the defendant.

It is further said that, even if there were at first any excuse for such "tacit understanding," and the Patent Office properly delayed action on this application until after the litigation between Drawbaugh and Bell had ended, a judgment therein was rendered in the Circuit Court in 1884; and that then the office should have proceeded promptly, and that there was no excuse for waiting until the decision of appeal by this court in 1888; and least of all for any delay after that final decision by this court.

Summing up their argument on this branch of the case, counsel say:

"The review of the history of the Berliner application which we have now completed shows that in its treatment of it the office proceeded upon two unlawful assumptions.

"The first was that an applicant, whose application is ready for issue except for a possible threatened interference, must wait until the antagonizing application is either found allowable and ready for the interference, or finally ejected from the office, no matter how long that may be. This assumption governed the action of the examiners from 1882 to the issue of the patent. . . .

"The second assumption was that the judicial determination of the question of Drawbaugh's invention, in the suit between the owners of the applications, was not enough to warrant action by the office. Examiner Kintner took the ground, in conversation with Mr. Swan—never on the record—that the decision of the Circuit Court was not enough for him; that the case might be appealed, and he would act only on the decision of the Supreme Court. But when that came, it received no more consideration than had been given to that of the Circuit Court."

Were it conceded that these two assumptions were "false assumptions," as counsel call them, what are they but errors of judgment on the part of the patent officials as to the course of procedure; and can it be possible that an applicant for a right, who has under the statute no choice of tribunals or course of procedure, but is compelled to apply to one tribunal which has exclusive jurisdiction in the matter, and must abide by its rulings as to procedure, can be held to have forfeited his right simply because of errors of judgment by such tribunal as to the procedure? The statement of the question seems to us to carry its own answer. It is true counsel follow this declaration of the errors on the part of the office in the matter of procedure with the further statement:

"The guilty party is the Bell Company. It had a full and perfect inside view of the whole situation from the beginning. Its attorneys were wiser in these things than the commissioners or the examiners. They shrewdly availed themselves of every unauthorized usage, mistaken assumption, ignorant misconception, or supposed obstacle, by means of which the issue of the patent could be delayed without apparent responsibility on their part. In view of the duty which vested upon the company to speed the application, that was fraud, not less but more reprehensible because it was not of the common and gross kind, but so refined and acute that its garb of professed innocence has deceived even the Court of Appeals."

The difficulty with this charge of wrong is that it is not proved. It assumes the existence of a knowledge which no one had; of an intention which is not shown. It treats every written communication from the solicitor in charge of the application, calling for action, as a pretense, and all the oral and urgent appeals for promptness as in fact mere invitations to delay. It not only rejects the testimony which is given, both oral and written, as false, but asks that it be held to prove just the reverse.

Indeed, the case which the counsel present to us may be summed up in these words: The application for this patent was duly filed. The Patent Office, after the filing, had full jurisdiction over the procedure; the applicant had no control over its action. We have been unable to offer a syllable of testimony tending to show that the applicant ever in any way corrupted or attempted to corrupt any of the officials of the department. We have been unable to show that any delay or postponement was made at the instance or on the suggestion of the applicant. Every communication that it made during those years carried with it a request for action, yet because the delay has resulted in enlarged profits to the applicant, and the fact that it would so result ought to have been known to it, it must be assumed that in some way it did cause the delay, and having so caused the delay ought to suffer therefor. There is seldom presented a case in which there is such an absolute and total failure of proof of wrong.

The defendant company might safely have left the case here, but it has not been content to rest the controversy with the failure on the part of the government to show any wrong. It has not been content to accept the Scotch verdict of "not proven." It has called as witnesses the examiners who were in charge of this application, and taken their testimony as to what did in fact take place, and as to how and why the long delay occurred. Whatever judgment may be pronounced upon the wisdom of the course pursued by these officials, or the sufficiency of the reasons given by them therefor, there is no ground for controverting that they acted in good faith. The case is not one of arbitrary, peremptory postponements and delay.

They supposed they were acting in compliance with the rules of the Patent Office, and out of proper regard for the rights of conflicting interests. No just estimate can be placed upon the propriety of their conduct without taking into consideration the whole subject of telephonic inventions and litigation. As heretofore stated, and as is well known, Bell claimed to be the pioneer in this matter of telephonic communication. His claim was disputed, and out of that dispute came the most important, the most protracted litigation which has arisen under the patent system in this country. For years this litigation was pending in the trial courts, subsequently brought to this court, and finally decided in 1888. So great was this litigation, so immense the volume of testimony, and so important the rights involved, that it is the only case in the history of this court to which an entire volume of our reports is devoted. (126 U. S.) The argument was protracted through weeks, and the case was held under consideration for a year, and finally decided by a closely divided court. Is it strange that when the primary right was being so vigorously contested, and was so much a matter of doubt, when (as appears from the testimony in this case) the judgment of the law department of the Government was adverse to the claims of Bell, and to the validity of the patent which he had obtained—is it strange, we ask, in view of these facts, that the disposition of the apparently minor matter should be held in abeyance in the Patent Office until a final decision of the primary right?

Neither can any just estimate be placed upon their conduct without taking into account the volume of business, and the pressure on account thereof, in the Patent Office. Beyond the fact, which is a matter of common knowledge, that thousands of applications are filed and thousands of patents granted each year, the record discloses something as to the multitude of applications for patents for telephones and telephonic devices which were pending during these years. Mr. Townsend, who was an examiner up to November 15, 1880, while unable to state the number of applications, was able to say that he had examined over 120 that went to patent. This, it will be remembered, was in the early days of telephonic investigation and invention. It appears, also, from a communication made by the Commissioner of Patents to the Secretary of the Interior, on December 13, 1892, advising against this suit, that at that time a gentleman, who is called in the letter the "relator," had pending in the Patent Office 152 applications for patents on telephones and telephone systems. These facts may be only side lights, but they show that the examiners and other officials in the Patent Office had something else to do besides considering this application.

Of course, it is easy to say that the Patent Office could have disposed of this application more promptly than it did; that it ought to have done so, and that, in view of the termination of the great litigation favorable to the claims of Bell, its delay has resulted in large pecuniary benefits to the defendant. But a wisdom born after the event is the cheapest of all wisdom. Anybody could have discovered America after 1492. The question is not whether a better judgment on the part of the patent officials would have disposed of this application long before it was, is not indeed whether there was any error of judgment, but whether they acted wrongfully and their action was induced by or at the instance of the defendant.

One thing more deserves notice. The argument of the counsel for the Government proceeds all along on the assumption of the superior knowledge of the representatives of the defendant company; that they saw the end from the beginning; that they knew that their client had an invention which was patentable and that they would ultimately obtain a patent therefor, and also that Bell was and would finally be adjudged the primary inventor of the telephone, and that possessed of all of this knowledge they planned the delay in securing the Berliner patent in order that thereby they might extend to the termination of its life the telephone monopoly. But what an assumption this is and how illy justified by the facts! The very process and termination of the Bell-Drawbaugh litigation demonstrates the doubtfulness of the question there in issue, and is absolute evidence that there was up to the close of that litigation an uncertainty as to the result. Equally uncertain was the outcome of the Berliner application. Indeed, there is an uncertainty as to every application. No one can foretell what will be the judgment of the Patent Office upon the questions of novelty and utility. And in respect to this Berliner application, the matters which are subsequently to be considered attest that there was more than ordinary doubt as to the outcome. On account of those matters it is earnestly contended that there was no merit in the application, and that it ought to have been denied. Further than that, they knew that the officials of the Patent Office were subject to change—as in fact they were changed during the pendency of these proceedings—and even if they had any direct intimations from the first examiner or the first commissioner, there was no certainty that a subsequent examiner and subsequent commissioner would entertain the same views. If the Bell-Drawbaugh litigation had terminated the other way, and a different opinion on the part of a single member of this court would have changed this result, or if when the time came the Commissioner of the Patent Office had decided against the Berliner application, and his decision been sustained on appeal to the Supreme Court of the District of Columbia, then

* For the copy of this important decision we are indebted to Mr. Justice Brewer.—EDS.

all this brilliant scheme of realizing millions would have vanished into thin air. If they were possessed of the wisdom which the Government attributes to them, the representatives of the Bell Company must have realized that the certainty which attends a final decision and the issue of a patent was something worth striving for, and not lightly to be ignored. And if this underlying assumption has so little foundation, what shall be said of an inference and an imputation unsupported by evidence and based upon that assumption?

Our conclusions on this branch of the case are: First, that before the Government is entitled to a decree canceling a patent for an invention on the ground that it had been fraudulently and wrongfully obtained, it must, as in the case of a like suit to set aside a patent for land, establish the fraud and the wrong by testimony which is clear, convincing and satisfactory. Second, that Congress has established a department with officials selected by the Government, to whom all applications for patents must be made; has prescribed the terms and conditions of such applications, and intrusted the entire management of affairs of the department to those officials; that when an applicant for a patent complies with the terms and conditions prescribed and files his application with the officers of the department he must abide their action, and cannot be held to suffer or lose rights by reason of any delay on the part of those officials, whether reasonable or unreasonable, unless such delay has been brought about through his corruption of the officials, or through his inducement, or at his instance. Proof that they were in fault, that they acted unwisely, unreasonably, and even that they were culpably dilatory, casts no blame on him and abridges none of his rights. Third, the evidence in this case does not in the least degree tend to show any corruption by the applicant of any of the officials of the department, or any undue or improper influence exerted or attempted to be exerted by it upon them, and on the other hand does affirmatively show that it urged promptness on the part of the officials of the department, and that the delay was the result of the actions of those officials. And, fourth, if the circumstances do not make it clear that this delay on the part of the officials was wholly justified, they do show that it was not wholly unwarranted, and that there were reasons for the action of such officials, which at least deserve consideration and cannot be condemned as trivial.

The three remaining grounds of relief asserted by the Government may be considered together. Defendants contend that as the last two, although urged in the Circuit Court, were not presented to the Court of Appeals (referring for this fact to the opinion of the latter court and also a notice which was contained in the brief of counsel for the Government), we are precluded from noticing them, citing as authority Bell v. Bruen (1 How. 169); Alviso v. United States (8 Wall. 337); National Bank v. Commonwealth (9 Wall. 353); Rogers v. Ritter (12 Wall. 317); Klein v. Russell (19 Wall. 433); Supervisors v. Lackawanna Co. (93 U. S. 619); Wilson v. McNamee (102 U. S. 572); Wood v. Weimar (104 U. S. 786); Topliff v. Topliff (145 U. S. 156); McGahan v. Bank of Rondout (156 U. S. 218); and Carr v. Fife (156 U. S. 494); in which cases, with more or less particularity, the proposition is announced that this court will not consider questions not presented to and passed upon by the lower court. We deem it unnecessary to determine how far that rule is applicable in this case, for the reasons which compel us to deny relief on the first of these grounds are, when applied to the facts developed by the testimony, equally potent as to the others. That ground, as stated, is "that a patent issued November 2, 1880, upon a division of the original application, covers the same invention as that covered by the patent in suit and exhausted the power of the Commissioner as to that invention." The patent of 1880 is for a receiver; that of 1891 for a transmitter. It is claimed that the two instruments are alike in form and alike in function, save as they are operated at different ends of the telephone wire. The transmitter can be placed at the other end of the wire and then becomes a receiver, and so vice versa. Popularly speaking, it may be said that the transmitter takes the varying sounds of the human voice and passes them on to the telephone wire, to be borne along thereon by the undulatory electric current until they reach the receiver, which takes and passes them to the human ear. In a sense the receiver is also a transmitter, for it passes the sounds from the wire to the ear. We agree with the Court of Appeals that it is unnecessary to determine whether there are two separate inventions in the transmitter and the receiver, or whether the patent of 1891 is for an invention which was covered by the patent of 1880. The judgment of the Patent Office, the tribunal established by Congress to determine such questions, was adverse to the contention of the Government, and such judgment cannot be reviewed in this suit.

Suits may be maintained by the Government in its own courts to set aside one of its patents not only when it has a proprietary and pecuniary interest in the result, but also when it is necessary in order to enable it to discharge its obligations to the public, and sometimes when the purpose and effect are simply to enforce the rights of an individual. In the former cases it has all the privileges and rights of a sovereign. The statutes of limitation do not run against it. The laches of its own officials does not debar its right. (Van Brocklin v. Tennessee, 117 U. S. 151; United States v. Nashville Railway Company, 118 U. S. 120; United States v. Insley, 130 U. S. 263.) But when it has no proprietary or pecuniary result in the setting aside of the patent; is not seeking to discharge its obligations to the public; when it has brought the suit simply to help an individual; making itself, as it were, the instrument by which the right of that individual against the patentee can be established, then it becomes subject to the rules governing like suits between private litigants. As said in United States v. Beebe (127 U. S. 338, 347):

"We are of the opinion that when the Government is a mere formal complainant in a suit, not for the purpose of asserting any public right or protecting any public interest, title or property, but merely to form a conduit through which one private person can conduct litigation against another private person, a court of equity will not be restrained from administering the equities existing between the real parties by any exemption of the Government designed for the protection of the rights of the United States alone. The mere use of its name in a suit for the benefit of a private suitor cannot extend its immunity as a sovereign government to said private suitor, whereby he can avoid and escape the scrutiny of a court of equity into the matters pleaded against him by the other party; nor stop the court from examining into and deciding the case according to the principles governing courts of equity in like cases between private litigants." See also United States v. Des Moines, etc., Co. (142 U. S. 510); Curtner v. United States (149 U. S. 662).

Now in the case at bar the United States has no proprietary or pecuniary interest. The result, if favorable to it, would put no money in its treasury or property in its possession. It has a standing in court either in the discharge of its obligation to protect the public against a monopoly it has wrongfully created, or simply because it owes a duty to other patentees to secure to them the full enjoyment of the rights which it has conferred by its patents to them. Perhaps both of these objects were in view. In so far as the latter was and is the purpose of this suit it brings it within the rule laid down in United States v. Beebe supra. Doubtless the removal from the public of the burden of a monopoly charged to have been wrongfully created was also one of the objects, and perhaps, the principal object. United States v. American Bell Telephone Company (159 U. S. 548). To what extent this may relieve the Government as suitor from all the rules governing the suits of private individuals need not be specifically determined here.

One of the familiar rules of equity, reinforced by statute (sec. 723, Rev. Stat.), is that "suits in equity shall not be sustained in either of the courts of the United States in any case where a plain, adequate, and complete remedy may be had at law." The objection to the validity of this patent on the ground that it was already covered by the patent of 1880 is a defense which under the statutes (sec. 4920, Rev. Stat.) is open to every individual charged by the patentee with infringement, whether the proceeding against him be an action at law or a suit in equity. The Government, therefore, if seeking simply to protect the right of an individual, ought not to be permitted to maintain a suit in equity to cancel that against which the individual has a perfect legal defense available in any action brought by or against him. The query is pressed whether the same rule would not also apply when the Government is only seeking to protect the public at large, for the public is but the aggregation of all the individuals, and if each of them has a perfect defense to the patent, so all together have. Again, and as an illustration perhaps of the extent of the rule referred to, it has often been held that while one having the title to and possession of a tract of land can maintain a suit in equity to cancel a deed or other instrument which is a cloud upon the title, such suit cannot be sustained if the deed or instrument is void upon its face, its invalidity resting upon matters of record, and not affected by any lapse of time or statute of limitations. In other words, the deed or instrument is not considered a cloud if it can never be used to destroy his title or disturb his possession. The objection to this patent on the ground stated is an objection resting upon matters of record—of record in the Patent Office; not dependent on oral testimony nor subject to change, and in no way affected by lapse of time. Within the scope of this specific application of the general rule it would seem that equity has no jurisdiction either at the suit of the Government or of an individual to formally cancel that which by record and unfailing evidence is, as claimed, absolutely void.

But, further, Congress has established the Patent Office, and thereby created a tribunal to pass upon all questions of novelty and utility. It has given to that office exclusive jurisdiction in the first instance, and has specifically provided under what circumstances its decisions may be reviewed, either collaterally or by appeal. As said in Butterworth v. Hoe (112 U. S. 50, 67): "That it was intended that the Commissioner of Patents, in issuing or withholding patents, in reissues, interferences and extensions, should exercise quasi-judicial functions, is apparent from the nature of the examinations and decisions he is required to make, and the modes provided by law, according to which, exclusively, they may be reviewed."

Sections 4911 to 4914, Rev. Stat., grant appeals in certain cases to the Supreme Court of the District of Columbia. It is true those sections do not authorize appeals on behalf of the Government, but the failure so to do may be evidence that Congress thought the Government ought not to interfere; and because it believed it had made ample provision for securing the rights of all without the intervention of the Government. Section 4915, Rev. Stat., authorizes a suit in equity on behalf of an applicant for a patent whose application has been refused. Morgan v. Daniels (153 U. S. 120) presented a controversy under that section, and in the opinion, on page 124, we said: "It is a controversy between two individuals over a question of fact which has once been settled by a special tribunal, intrusted with full power in the premises. As such it might be well argued, were it not for the terms of this statute, that the decision of the Patent Office was a finality upon every matter of fact."

It is true that all these sections refer to proceedings between individuals, but the government is as much bound by the laws of Congress as an individual, and when Congress has created a tribunal to which it has given exclusive determination in the first instance of certain questions of fact and has specifically provided under what circumstances that determination may be reviewed by the courts, the argument is a forcible one that such determination should be held conclusive upon the Government, subject to the same limitations as apply in suits between individuals.

There is nothing in United States v. Bell Telephone Company (128 U. S. 315) and United States v. American Bell Telephone Company (159 U. S. 548) to conflict with the views above expressed. In the former case the question presented was whether the Government could maintain a bill to set aside a patent for an invention on the ground of fraud in its issue, and among the objections urged was the fact that Congress had, in section 4920, Revised Statutes, made specific provision for certain defenses in suits by an infringer. It was held that the government could maintain such a bill, and that these special statutory provisions did not defeat its right, the court summing up the discussion in these words (p. 373):

"The argument need not be further extended. There is nothing in these provisions expressing an intention of limiting the power of the Government of the United States to get rid of a patent obtained from it by fraud and deceit. And although the legislature may have given to private individuals a more limited form of relief, by way of defense to an action by the patentee, we think the argument that this was intended to supersede the affirmative relief to which the United States is entitled, to obtain a cancelation or vacation of an instrument obtained from it by fraud, an instrument which affects the whole public whose protection from such a fraud is eminently the duty of the United States, is not sound."

In the latter case, which is the one now before us, there was decided a motion to dismiss for want of jurisdiction in this court of an appeal from the decision of the Court of Appeals, and it was adjudged that this court had jurisdiction. It is true, at the close of the opinion is found this general statement as to the power to maintain such a suit (p. 555):

"In United States v. Telephone Company (supra), it was decided that where a patent for a grant of any kind issued by the United States has been obtained by fraud, by mistake or by accident, a suit by the United States against the patentee is the proper remedy for relief, and that in this country, where there is no kingly prerogative, but where patents for land and inventions are issued by the authority of the Government, and by officers appointed for that purpose, who may have been imposed upon by fraud or deceit, or may have erred as to their power, or made mistakes in the instrument itself, the appropriate remedy is by proceedings by the United States against the patentee."

But while there was thus rightfully affirmed the power of the Government to proceed by suit in equity against one who had wrongfully obtained a patent for land or for an invention, there was no attempt to define the character of the fraud, or deceit, or mistake, or the extent of the error as to power which must be established before a decree could be entered canceling the patent. It was not affirmed that proof of any fraud, or deceit, or the existence of any error on the part of the officers as to the extent of their power, or that any mistake in the instrument was sufficient to justify a decree of cancelation. Least of all was it intended to be affirmed that the courts of the United States, sitting as courts of equity, could entertain jurisdiction of a suit by the United States to set aside a patent for an invention on the mere ground of error of judgment on the part of the patent officials. That would be an attempt on the part of the courts in collateral attack to exercise an appellate jurisdiction over the decisions of the Patent Office, although no appellate jurisdiction has been by the statutes conferred. We are of opinion, therefore, that the question, as stated, is not open for consideration in this case. We see no error in the decision of the Court of Appeals, and its decree, dismissing the bill, is Affirmed.

Mr. Justice Harlan dissented.

Mr. Justice Gray and Mr. Justice Brown were not present at the argument, and took no part in the decision.

THE VALUE OF PATHOLOGICAL RESEARCH.*

ON the occasion of the jubilee of Queen's College, Belfast, last January, the new physiological and pathological laboratories were formally opened by the Lord Lieutenant. On the following day an address of welcome and congratulation was presented by the North of Ireland Branch of the British Medical Association and the Ulster Medical Society to Lord Lister, who, after receiving it, spoke as follows:

It gave me very great pleasure to witness the opening of the physiological and pathological laboratories yesterday by His Excellency the Lord Lieutenant. Such an establishment is calculated to be of enormous advantage to the North of Ireland. The benefits which it will confer will be of various kinds. In the first place, it will be of very great assistance to the medical practitioner in forming his diagnosis of the disease of the patient he has to treat.

In these days the knowledge of pathology has made immense advances; and, at the same time, along with those advances in pathological knowledge, there has arisen increased complexity in the methods of examining pathological objects. Section cutting, staining, microscopic examination—these are matters of the utmost moment; and yet for the general practitioner there may be neither the apparatus nor the time requisite for that kind of investigation. It will, therefore, be of great advantage to the practitioner, when he has removed or in any way obtained a portion of a morbid growth, to send it to a central institution, and have absolutely definite information as to the precise nature of the disease with which he has to deal. Then, as regards the bacteriological department—there, again, diagnosis will be greatly facilitated. You are most of you aware that the diagnosis of diphtheria can now be made by bacteriological examination. It is of the utmost importance in the treatment of a case of diphtheria that its nature should be distinctly defined; that it should be known with certainty whether it is true diphtheria or a disease which closely simulates it, and may deceive the most experienced practitioner, and yet have none of the deadly characteristics of true diphtheria.

Now for the future any medical man in the North of Ireland will only have to send, in a suitable tube, which will be provided by the institution, a little of the false membrane in the case with which he is dealing, and in a very short time he will have sent to him a bacteriologically made diagnosis of whether it is a case of true diphtheria or not. Again, with reference to what is more immediately connected with the objects of this college, such an institute will be of very great help in the training of students in their education for the medical profession. In it the student will have the opportunity of practically studying the various forms of morbid growth and the diseases which are of the nature of microbes. These are days when the subjects of medical examination are becoming more and more complex, and the student is too much tempted to get up his knowledge

* An address delivered January 20, in connection with the opening of the new physiological and pathological laboratories in Queen's College, Belfast, during the celebration of the jubilee of the College, by Lord Lister, P.R.S.—From Nature.

in a superficial way, cramming to satisfy the examiner, rather than to obtain thoroughgoing, practical information. That is more especially the case when the student is not examined by his own teachers, under whom he might work with some confidence that his labor would not b thrown away with reference to that really subordinate, but in his eyes vastly important, matter of the passing of his examination.

May I venture to interpose a remark on that point, and to express the hope that the time is not very far distant when the great northern metropolis of Ireland will have its own university, a true teaching and graduating university on the same lines as most of the German universities and the Scotch? But passing from that, independently altogether of the difficulty a student may have in preparing for examination by strangers, the great complexity of the subjects of medical education makes it extremely important that there should be afforded ample opportunities of practical study. The bacteriological department will be of peculiar value in the education of the student. It will in the first place convince him of the reality of the microscopic foes with which we have at the present day so largely to deal—the microbes, which are the cause of so large a proportion of human disease. He will not only read that such things are, and when he gets into practice perhaps forget that they exist, but he will know them as acquaintances. He will see the evidence not only of their existence, but also of their effects.

The bacteriological training will, besides, be of special advantage in teaching the student accurate observation and also dexterity of manipulation—both most important matters in a medical man's practice. If a student is told to prepare a culture of a particular microbe in a state of purity, in order to do that he must be very sharp indeed in his observations, and very clever, too, in his manipulations; and, if he fails, the fact will very soon declare itself. There will be an impure culture, and instead of having only the one microbe he wished to cultivate, with its well known special characteristics, it will be seen that he has allowed others to get in at the same time. His own imperfections will thus declare themselves, but he will persevere, and go on and on until he becomes perfectly competent to produce a pure culture. This will be of great importance in his education.

There is another aspect of a pathological institute which I feel some delicacy in alluding to, because there are some people who take strange views with regard to these matters—exaggerated views. There are people who do not object to eating a mutton chop—people who do not even object to shooting a pheasant with the considerable chance that it may be only wounded and may have to die after lingering in pain, unable to obtain its proper nutriment—and yet who consider it something monstrous to introduce under the skin of a guinea pig a little inoculation of some microbe to ascertain its action. Those seem to me to be most inconsistent views.

With regard to all matters in which we are concerned in this world, everything depends upon the motive. A murderer may cut a man's throat to kill him; any one of your medical students may have to cut a man's throat to save his life. The father who chastises his son for the sake of the good of his morals is a most humane man; a father who should beat his son for the mere sake of inflicting pain upon him would be an inhuman monster. And so it is with the necessary experiments upon lower animals. If they were made, as some people seem to assume, for the mere sport of the thing, they would be indeed to be deprecated and decried; but if they are made with the wholly noble object of not only increasing human knowledge, but also diminishing human suffering, then I hold that such investigations are deserving of all praise. Those little know who lightly speak on these matters how much self-denial is required in the prosecution of such researches when they are conducted, as indeed they always are, so far as I am aware, with the object of establishing new truth. The exercise of a little charity might lead those who speak of us as inhuman to reflect that possibly we may be as humane as themselves.

The profession to which I have the great honor to belong is, I firmly believe, on the average, the most humane of all professions. The medical student may be sometimes a rough diamond; but when he comes to have personal charge of patients, and to have the life and health of a fellow creature depending upon his individual care, he becomes a changed man, and from that day forth his life becomes a constant exercise of beneficence. With that beneficence there is associated benevolence; and, in that practical way, our profession becomes the most benevolent of all. If our detractors knew this, common sense would enable them to see that our profession would not be unanimously in favor of these researches if they were the iniquitous things which they are sometimes represented to be.

I was reading the other day a very interesting account of Pasteur's work on rabies, written by one who was associated with him from an early period (M. Duclaux). It had been established that the introduction of a portion of the brain of a mad dog under the skin of a healthy animal was liable to cause rabies, and Pasteur had reason to believe that it was principally in the nervous centers that the poison accumulated. He felt a very strong desire to introduce some of the poison into the brain of an animal; but he was a peculiarly humane man. He never could shoot an animal for sport. He was more humane than the great majority of human beings; and for a long time he could not bring himself to make the experiment of trephining an animal's skull, and introducing some of the poison of rabies into the brain. He was exceedingly desirous of doing it to establish the pathology of the disease, but he shrank from it.

On one occasion, when he was absent from home, one of his assistants did the experiment, and when Pasteur came back he told him that he had done so. "Oh!" said Pasteur, "the poor creature! His brain has been touched. I am afraid he will be affected with paralysis." The assistant went into a neighboring room and brought in the animal, which was a dog. It came in frisking about and investigating everything in a perfectly natural manner; and Pasteur was exceedingly pleased, and though he did not like dogs, yet he lavished his affection upon that particular animal and petted it, and from that time forth he felt his scruples need no longer exist.

The truth is that the pain inflicted by this process of trephining is exceedingly slight, and yet the operation is sometimes described as being a hideously painful one. That is a mistake. In point of fact the operation is always done now under anæsthetics, so that the animal does not feel it at all, but even without that the operation is not seriously painful. I look forward to the time when there will be an institute in connection with this college, where investigations of the kind to which I have referred can be carried on, and where pathological knowledge of the first importance may be promoted.

Think also of the practical advantages of an institution where the materials can be provided for the treatment of diseases on the principles which have been recently established. It appears to be now placed beyond doubt that that dreadful disease diphtheria may, by the antitoxic treatment, be reduced in mortality from about thirty per cent. to about five per cent., if the proper material is promptly used.

It is exceedingly important that in a city like Belfast the supply of such material should be within easy reach of the practitioner—that he should not be compelled to send to London for the requisite serum, and thus lose much valuable time. Every hour that is lost in the treatment of a case of this nature is a very serious loss indeed. But it is by no means only in diphtheria that such an institute is likely to confer benefits of this kind. In the case of the streptococcus, which is the cause of erysipelas and kindred disorders, including that very terrible disease, puerperal fever, there are very promising indications that the use of antitoxic serum will rescue patients from otherwise hopeless conditions. Let any one picture to himself the case of a young wife after her first confinement afflicted with this dreadful puerperal fever, and doomed under ordinary treatment to certain death. The practitioner makes an injection of this serum under the skin, with the result that the lady rapidly recovers, and in a few days is perfectly well. Let any man conceive such a case as this, and all objections to the investigations necessary to bring about such a state of things must vanish into thin air. So soon as our poor selves are directly concerned, our objections disappear. If a tiger threatened to attack a camp, who would care much about what kind of a trap was set for it, or what suffering the trap caused the animal, so long as it was caught? When the matter affects only the welfare of others, including generations yet unborn, the good done does not appeal to the individual, and the objector sees only the horrors of modern scientific investigation; of which horrors, however, he quickly loses the sense as soon as he becomes personally concerned.

On the occasion of the funeral of that illustrious investigator to whom I have before referred, I visited the Institut Pasteur, and there was shown preparations of the microbe of the plague discovered at Hong-Kong in 1894, by M. Yersin. And I was told by M. Roux, that Yersin, whom he knew intimately as formerly his colleague, had lately been treating in China several cases of that fearful disease with serum prepared at the Institut Pasteur on the same lines as that used for diphtheria. Cultures of the plague bacillus had been taken to Paris, and at the Institut, under the most rigorous precautions, the serum had been prepared. At the Institut they did not think they had succeeded in producing a very powerful serum, judging from its action on animals; but in the human subject it seems to have proved most potent. M. Yersin obtained serum sufficient for the treatment of twenty-six cases of the plague. The mortality from the disease at the time was above 80 per cent. The first case which he treated was that of a young man, in whom a "bubo," characteristic of the disease, was present, and the patient, already delirious, was completely despaired of. A little of the serum was introduced, and, to M. Yersin's absolute amazement, on the next day the young man was well, the bubo having almost entirely disappeared; and, moreover, of the twenty-six cases in which M. Yersin used the serum, twenty-four recovered, while in the remaining two Yersin felt that he was called in so late that their cases were hopeless. I would not have referred to these facts did I not know that the person from whom they were obtained was absolutely trustworthy. We cannot tell how soon the plague may visit these shores. We know that in one of our great dependencies—Bombay—it is already prevalent in a very severe form, and has already cost many lives. We know that a ship may carry the disease; that rats are liable to contract it, and that a rat making its escape from a ship coming from Bombay, say, to the Thames or to Belfast Lough, may carry the plague ashore, and that the taint may be communicated to human beings, with dreadful results. I would not say that there are not slums in the city of Belfast which might harbor the plague. So you can easily recognize how vastly important it would be to have means at hand whereby, in the simple way I have described, the disease may be combated. I have, I think, said enough to show the vast importance of an institute of such a character, and I look forward to the time when you will have such an establishment thoroughly equipped for its beneficent work.

There is another department in connection with medical education in this city about which I cannot speak in the same terms of praise as I can with reference to the new laboratories, and that is the hospital. No doubt the Royal Hospital, which I had the honor of visiting for the first time yesterday, is a fine institution; but it is altogether inadequate to the requirements of this great and rapidly growing city. It is inadequate, whether for affording means of clinical instruction to students or for dealing with the diseases of your large and increasing population. But I am glad to know that there is a prospect of better things before long. I understand that it has been not merely contemplated, but determined, to build a large new hospital, provided the requisite funds can be obtained; and I have been informed that within six weeks of the initiation of the movement more than half the necessary sum has been raised. I have no doubt that the munificence of the merchant princes of Belfast will soon provide the balance. Therefore, whichever way I look at this jubilee, I feel that the college, more particularly with regard to its medical school, is entering upon a new era of prosperity. I rejoice with you in the fact, and I have felt it a great privilege to take part in your celebration.

[Since this address was delivered, the last number of the Annales de l'Institut Pasteur has appeared, containing a paper by M. Yersin, describing his experience above referred to. The details which he gives of the cases confirm in a remarkable manner the conclusion which the mere numbers suggest. Just as in diphtheria, and exactly as must occur if the antidote is really efficacious, the cure was most rapid when the treatment could be commenced on the first day of the disease; speedy also, but less so, when it was begun on the second day; and so from day to day till the fifth. Four patients were treated at this very late period, and the only failures were in two of these. More of the serum also was required in the more advanced cases.

Equally striking was the manner of recovery. In none of the twelve cases in which treatment commenced within two days after the onset of the complaint did the bubo suppurate. And in those of a later period in which matter did form, the abscess closed rapidly after being opened, instead of healing tediously, as it does when recovery takes place without this treatment. And the patients, instead of having a lingering convalescence, were healthy men and women in a time which was always relatively short, and astonishingly so when the treatment had been commenced early. These details are so extraordinarily confirmatory that, small though the number of cases is, they carry conviction to my own mind.

It gives me the most profound satisfaction to be able to state on the authority of the India Office that the Bombay government intend to employ M. Yersin, now on his way to the stricken region, to give a full trial of his method, and I have also learned through another channel that within a fortnight from this time (February 1) the serum treatment will probably have begun in Bombay. LISTER.

SIXTY YEARS OF GEOLOGICAL RESEARCH.*

As in the case with all other sciences, the progress of geology has become more rapid and its results have become more appreciated in proportion to the spread of education among the peoples as a whole. Even in the old days of book learning pupils were at least trained to read books, and hence the discoveries of scientific men became in due time accessible to the many. Gradually it was seen that in the observation of the world around us lay the only safe clew to the history of that world in long past ages; and a band of workers arose about the beginning of this century prepared to treat geology as a branch of natural history rather than as a ground for dogmatic contention and for the exploitation of theories of cosmogony.

Already, in 1807, the foundation of the Geological Society of London had brought together serious observers and had provided a meeting ground for those interested in the mineral or the palæontological aspects of the earth. The Geological Society of Dublin commenced its publications in 1832, that of Liverpool in 1859 and that of Glasgow in 1864, while the well known Geologists' Association, founded in 1858, has kept hundreds in constant touch with the field work which is the foundation of geological discovery. Thanks to the steady growth of this organization and of the "field clubs," whose best meetings are held in the open air, geology has assumed its place at the present time as one of the most attractive sciences; and its human aspect, the insight that it gives us into the long chains of life forms which preceded the appearance of man upon the globe, affords it, in our evolutionary days, increased importance and vitality.

The general spread of some knowledge of chemistry and physics in our schools and institutes—I write, at least, of England and of Scotland—promises that the new observers in geology will receive a more rigid training than was customary sixty years ago. In 1830 Lyell published the first volume of his famous "Principles of Geology;" and he still found arrayed against him those who preferred rapid speculation to steady observation, and the reporting of "curiosities of travel" rather than the recording of connected details. Though Lyell himself cannot (mainly on account of his defective eyesight) be classed among the great geological discoverers, yet his methods of work, his continual adaptation of the known processes of the present to the explanation of past phenomena, make him rank among the foremost teachers of the age. His caution, his very respect for the recurring cycles of James Hutton (1795), who had founded the "uniformitarian" school, made him at first skeptical as to the reality of organic evolution; but his acceptance of the views of Darwin and Wallace, very shortly after the publication of the "Origin of Species," gave a great and further stimulus to geology. Geology has since gone hand in hand with zoology in seeking to unravel the past history of the earth; and the catastrophic school, of which even Cuvier was a supporter, has reserved its epochs of deluge and explosion for periods before life existed on the globe.

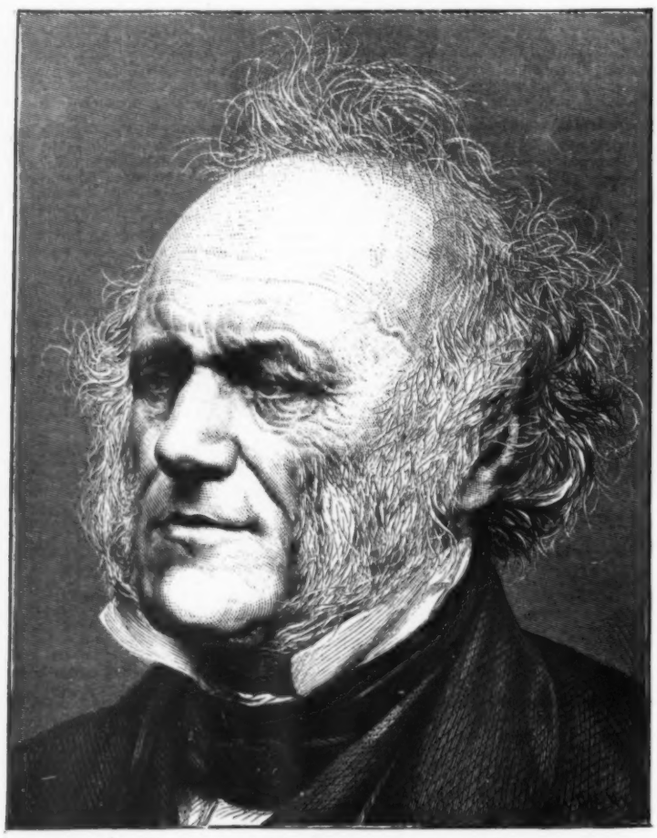
With the acceptance of rational views as to the origin of the rocks which we see around us, the systematic study of the organic remains found in them became a matter of more serious interest. The foundations of historical geology had been laid by William Smith, the land surveyor and engineer, between 1790 and 1815; and Lyell's classification of the stratified rocks that were formed nearest to our own times was only an advanced and special study on Smith's principles. Lyell established the well known terms pliocene, miocene and eocene, and showed what immense changes had gone on in the earth's surface even during these more recent periods. His demands on time were naturally repugnant to those who still held that the earth and all that therein is had existed for only some six thousand years; and physicists, even in later times, have stoutly opposed the geologists in their views of the extreme antiquity of life upon the globe. In the last few years, however—as Mr. Poulton has very clearly set forth in his address to the zoological section of the British Association in 1896—physical experiment has shown that the earth's crust would have reached its present temperature, on the surface of a cooling globe, in a time vastly longer than the physicists were formerly able to concede; and, consequently, geological time, though of course not limitless, may be restored to us in something like the proportions insisted on by Lyell.

It is thus much more easy to conceive the successive evolution of the various life zones that mark out the strata one from another. In 1859 Charles Darwin's "Origin of Species" afforded satisfactory reasons for

* By Grenville A. J. Cole, M.R.I.A., F.G.S., Professor of Geology in the Royal College of Science for Ireland.—Knowledge.

regarding fossil organisms as a continuous series, the forms of one geological epoch having descended from those of a previous one; and fossils, instead of being treated as more or less imperfect experiments in creation, became the essential alphabet whereby we may trace out the progress of life upon our planet. It was only to be expected that at first many rash genealogies should be put forward, and that many supposed "connecting links" should have later to be shorn away. Even at the present time the methods of William Smith, involving patient observation as to the relations of the beds themselves, form the only safe basis in deciding the succession of life forms.

The Palæontographical Society undertook in 1847 the description and delineation of all British fossil species; and the magnificent series of quarto volumes issued up to the present time more than rivals the ambitious publications of the opening years of the century. Owen, who seemed a lineal successor of Cuvier, brought together into the collections of the British Museum a series of fossil vertebrates from all lands; and many of Huxley's laurels were gathered while investigating similar remains. The discovery of the relationships in structure between the skeletons of many of the enormous reptiles of the mesozoic era and the light-limbed birds that seem to have arisen side by side with them, is one of the most striking results of these studies in comparative anatomy. While Mantell, Owen, Hulke, Seeley and other workers have put before us the variety and richness of British reptilian remains, Marsh and Cope have attacked the American fossil vertebrates, and have restored a long series of dinosaurs from the trias to the highest beds of the cretaceous, which have given us altogether new conceptions of the age of giant reptiles. At the same time the permian and triassic reptiles of Texas and South Africa have been shown to embody hints of the incoming of the mammals, the group of the "Theromorpha" being far less specialized along the reptilian line than are the reptiles of the present day. Owen's tritylodon, from the Karoo beds of South Africa, remains our best preserved and oldest mammalian skull; and the recent investigation of the milk teeth of ornithorhynchus has shown relationships between the earliest known mammals and the lowest existing order, the monotremes.



SIR CHARLES LYELL, F.R.S. 1797–1875.

The "doctrine of descent," so strongly supported and vindicated by Darwin's treatise of 1859, has found the fullest confirmation in these and other facts of palæontology. The splendid series of remains of fossil horses known to us, illustrating the successive changes in dentition and in limb bones, and notably in the digits of the foot, has furnished an example that is dealt with now in every text book. Cope has even argued for the independent origin of the horse, as a species, in America and in Europe, by similar selective influences acting on slightly dissimilar original stocks.

It must never be forgotten that Darwin himself stands in the first rank of geological observers, whether among raised beaches or ancient lava flows or the coral isles of the Pacific. His diary of his share in the voyage of H. M. S. Beagle appeared as Volume III of the joint report in 1839; but his special geological researches were published in 1842 (coral reefs), 1844 (on volcanic islands), and 1846 (on South America).

In this last named year the newly formed Geological Survey of Great Britain issued its first volume of memoirs; the Ordnance Survey of Ireland had published Portlock's "Report on the Geology of Londonderry," etc., three years earlier. De la Beche, Ramsay and Sir Archibald Geikie—the last named being equally known as a man of letters—have successively directed the British Survey. Similar surveys were undertaken by most of the European states; and we owe the fine series of geological maps of the British Isles, the 1:80,000 survey of France, the intricate results set down in the Swiss sheets, and such admirable traveling companions as Van Hauer's map of the Austrian empire, entirely to the labors of geologists during the last sixty years. Geological mapping is no longer a mere record of the rocks or minerals found at various points on the earth's surface: the relative ages of the strata can now be ascertained by their fossil contents; and William Smith's original sketch map of England and Wales, published in 1815, and colored upon this basis, has, by our time, borne abundant fruit.

We cannot pass over the striking work of the Geological Survey of India, carried on under difficulties little experienced in Europe; or the great series of volumes, a monument of public liberality, devoted to geology by the Survey of the United States. Japan and Mexico, among other countries, now furnish their full contribution to the store of geological research.

Our knowledge of structural geology has progressed with the spread of these accurate surveys, and private workers have occasionally shown how much may be done by patient investigation of a critical district, if aided by that power of comparison and generalization which converts the work of a recorder into that of a scientific master. Prof. Lapworth has thus unraveled the complex region of Northwest Sutherland, and has shown us, since 1883, how we have in our highlands the basal sections of truly Alpine mountain chains. Heim in Eastern Switzerland, Baltzer and others in the Central Alps, Bertrand in the Juras, Lory in Savoy and in Dauphiné, have revealed the amount of intermingling and overfolding that has gone on in these regions since oligocene times. The relations of the central granitic and gneissic cores of mountain chains to the strata upon their flanks becomes one of the most interesting questions raised; and it appears that, far from being the oldest masses, thrust up from below, these cores often represent remelted material, which flowed into its present position during the actual period of mountain building. Similarly, Dr. Lawson has shown in Canada that the "laurentian" gneiss is intrusive in the Huronian series, and is thus, in part at any rate, by no means the fundamental mass that it was once believed to represent.

The publication between 1883 and 1888 of Das Antlitz der Erde by Dr. Suess, of Vienna, has exercised a most important influence on students of physical geology. This applies particularly to the relations between the levels of land and water in the past and between areas of elevation and depression on the earth's surface. The action of old rock masses in determining the lines of later earth movement has here been emphasized effectively.

Probably no physical problem has been attacked by geologists more keenly than that of the "Great Ice Age." Since Agassiz, Ramsay and others pointed out, about 1850, how large a part of the northern hemisphere must have been subject to Arctic conditions of snow and ice, and that these conditions must have prevailed in quite recent geological times, theory after theory has been put forward to account for the widespread phenomena. Prof. James Geikie published his "Great Ice Age" in 1874—a work now in its third edition—and may be regarded as the strongest champion of the land ice theory. Gigantic glaciers, extending even from the pole, have been invoked by some, while others prefer a combination of land ice from local centers, with floating ice bringing bowlders from a distance. The cold epoch being a certainty, Dr. Croll (a review of whose life appeared in Knowledge for April, 1897) set himself to account for it on astronomical grounds; and his elaborate theory, promulgated in "Climate and Time," in 1875, held sway over the majority of geologists. Quite recently, however, Mr. E. P. Culverwell has reinvestigated the problem on a more modern basis, and regards the astronomical theory as entirely insufficient; so we may be thrown back on what were to Croll, after all, important considerations—the effect of changes in the distribution of snowfields, land and sea, particularly by causing deviations in currents of warm air and water.

While geology began its career as a close ally of mineralogy, the excitement of palæontological discovery for a long time caused the rocks themselves to be little studied. The microscopic observations of Cordier on the constitution of lavas, carried out in 1815, bore little fruit until 1856 and 1858, when Dr. Sorby, of Sheffield, drew attention to the value of the microscope in determining the characters and mode of origin of rocks. Delesse, in France, had been a faithful student of polished surfaces; but Sorby now introduced the general use of sections or of powdered materials embedded in Canada balsam. The study of minerals in situ by this method became a favorite one in Germany and France, and we owe some of the most important determinative tests to Fouqué, Levy, Rosenbusch and Groth, to mention no other names. The establishment of the first geological laboratory by Prof. Judd in 1877, whereby the teachers trained under the Department of Science and Art, as well as the students of the Royal School of Mines, received practical courses of instruction, probably did more than any other influence to promote the study of rocks in the British Isles and in our colonies. There is little fear now, moreover, of British students becoming adepts in the use of microscopic sections, and forgetful of the true relations of rock masses in the field. The position of geology as an educational subject rests largely upon its outdoor aspects; and Anglo-Saxon geologists have always preferred to base their classification of rocks upon natural relationships traceable in the field.

We have left until the last one of the most vital problems of geological research, and one that gives to geology, if we may say so, its enormous moral value. When Lyell published in 1863 his work on "The Geological Evidences of the Antiquity of Man," he was able to take up an attitude of marked opposition to the prevalent opinions of his day. Early flint implements were, even then, only beginning to be studied, and human remains are notably prone to disintegration and decay. Still, Lyell was able to point to the upper part of a skull discovered in the Neanderthal in 1857, and to Huxley's description of it, as indicating a type of extinct humanity far lower than that of the average of the present day. Considering the paucity of very ancient human remains, the discovery of two skeletons with skulls of the Neanderthal type at Spy, in Belgium, in 1886, gave immense probability to the idea that a race of men of low average capacity may have at one time peopled the earth; and in October, 1891, Dr. Dubois excavated from volcanic sands near Trinil, in Java, the calvarium described by him as Pithecanthropus erectus. This portion of a skull, with a well developed thigh bone, and a molar tooth, were found associated with truly extinct and also locally extinct mammalia, and are referred by Dubois to an individual actually intermediate between man and the anthropoid apes. Other discoveries in this promising area must be looked for before geologists and anthropologists are all in accord as to the significance of these remarkable remains.

Section of Olivine-basalt from Isle of Mull, as seen under Microscope, × 25. a, augite; p, plagioclastic felspar; ol, olivine.

Meanwhile Dr. Fritz Noetling, of the Indian Survey, discovered artificially chipped flint implements in pliocene beds in Burma in 1894, and has rebutted his critics with considerable appearance of success in a second paper in Natural Science in April of the present year. In the February number of the same journal Mr. W. J. Lewis Abbott records similar implements from the Cromer forest bed; and few geologists can remain who would deny to man an existence in preglacial times. What forms preceded reasoning man may still be left in darkness; but the extreme skepticism of some archæologists and the self-satisfaction of those who have failed to follow the course of palæontological discovery can no longer check research into this difficult and fascinating field.

In conclusion, whatever impressions have been made by gifted public teachers, we must never forget that each generalization in geology has been founded on a multitude of researches published in our scientific journals. Hidden away there, known only to the specialist, lie the foundation stones of the science. In the multiplication of scientific observers, in their frequent self-sacrifice, in the high dignity of their aims, we may see the most stimulating outcome of the progress of these sixty years.

THE CASA GRANDE RUIN, SOUTHERN ARIZONA.*

By COSMOS MINDELEFF.

SITUATED near the Gila River, in Southern Arizona, is perhaps the best known specimen of aboriginal architecture in the United States, and no treatise on American antiquities is complete without a more or less extended description of it. Its literature, which extends over two centuries, is voluminous, but of little value to the practical scientific worker, since hardly two descriptions can be found which agree. The variations in size of the ruin given by various authors is astonishing, ranging from 1,500 square feet to nearly five acres or about 200,000 square feet in area. These extreme variations are doubtless due to difference of judgment as to what portion of the area covered by remains of walls should be assigned to the Casa Grande proper, for this structure is but a portion of a large group of ruins.

The earlier writers generally state that the Casa Grande was in ruins at the time of the first Spanish invasion of the country, in 1540, and quote in support of this assertion Castaneda's description of a ruin encountered on the march, Castaneda saying, "The structure was in ruins, and without a roof." Elsewhere he says that the name "Chichiltícale" was given to the place where they stopped because the monks found in the vicinity a house which had been inhabited by a people who came from Cibola. He surmises that the ruin was formerly a fortress, destroyed long before by the barbarous tribes which they found in the country. His description of these tribes seems to apply to the Apache.

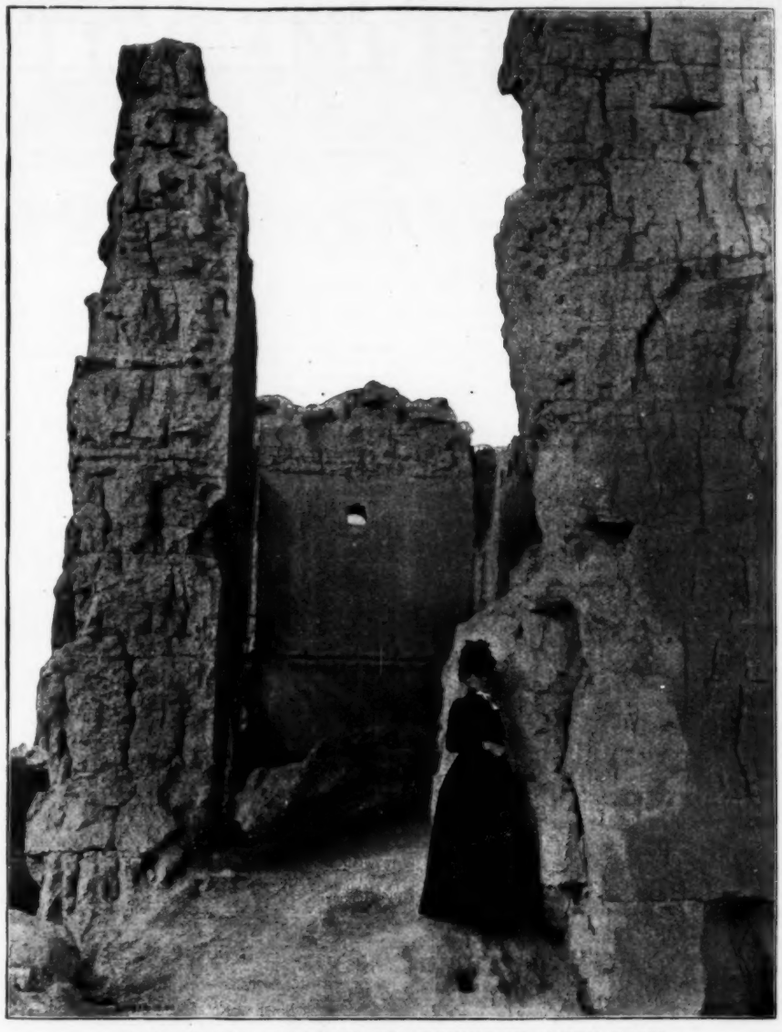
In 1694 the Jesuit Father Kino heard of the ruin, and later in the same year visited it and said mass within its walls. His secretary, Mange, describes it as "a large edifice, the principal room in the center being four stories high, and those adjoining it on its four sides three stories, with walls two varas thick, of strong avgamaso y baro (adobe), so smooth on the inside that they resembled planed boards, and so polished that they shine like Puebla pottery." Mange also states that there were in the immediate vicinity the remains of twelve other buildings, the walls half fallen and the roofs burned out. There have been many subsequent descriptions, among the latest being those of members of the Hemenway southwestern archæological expedition.

The ruin is about half a mile from the Gila River, directly on one of the stage routes from Casa Grande station, on the Southern Pacific Railroad, to Florence, Arizona, and about nine miles below or west of the latter place. The name has been usually applied to a single structure standing near the southwestern corner of a large area covered by mounds and other debris, but some writers have applied it to the southwestern portion of the area and even to the whole area, the name Casa Grande ruin being, perhaps, more properly applied to the single structure with standing walls. It occupies a position near the southwestern corner of the group of ruins, and its size is magnificent as compared with that of the entire group, or even with the large structure in the north central part of the group.

For miles about the Casa Grande ruin, a general view of which is given in one of the illustrations, the ground surface is so flat in every direction that from the summit of its walls an immense stretch of country is brought into view. The area covered and inclosed by standing walls is about 43 by 59 ft. The building comprised three central rooms, each approximately 10 by 24 ft., and two other rooms, each about 9 by 35 ft. Except the central room, which was three stories in height, all the rooms were two stories above the ground. The northeastern and southeastern corners of the structure have fallen, and large blocks of the material of which they were composed are strewn upon the ground in the vicinity. It is not likely that the main building originally stood alone, as at present, and the area immediately adjacent, now covered by mounds, probably carried buildings of the same time with the main structure. The exterior walls rise to a height of 20 to 25 ft. above the ground, and in the middle space the walls are now 28 to 30 ft. above the ground level. The exterior of the walls is rough, but the interior walls of the rooms are finished with remarkable smoothness, this fine finish being apparent in the illustration showing a square opening in the south room. The walls at the base are from 2½ to 5 ft. thick, and at the top are reduced to about 2 ft.

The building was constructed by crude methods, thoroughly aboriginal in character, and there is no uniformity in its measurements. The walls, even in the same room, are not of even thickness, and the floor joists were seldom on a straight line. The adobe of which the building is constructed is not the usual moulded brick dried in the sun, but the walls are composed of huge blocks of clayey earth, probably formed in place in a box or trough held in a framework of canes or poles. The material, when dry, became almost as hard as sandstone, and practically indestructible, in the clim-

* Condensed from an exhaustive paper in the Thirteenth Annual Report of the Bureau of Ethnology, Washington, D. C., J. W. Powell, Director.



CASA GRANDE RUIN—SQUARE OPENING IN SOUTH ROOM.

GENERAL VIEW OF CASA GRANDE RUIN.

ate of the region. The damage done by relic hunters in the last twenty years has been probably much greater than that wrought by the elements in the preceding two centuries. The writer has been reliably informed that as late as twenty years ago a portion of the floor or roof in one of the rooms was still in place, but at the present day nothing is left of the floors except marks on the vertical walls, and a few stumps of floor joists, deeply embedded in the walls, and so high that they cannot be seen from the ground.

FLUID AIR FOR INDUSTRIAL USES.*

LIQUEFYING air is not a new thing; it has been performed by exerting enormous pressure or by freezing air to an unusual degree, or by a combination of pressure with refrigeration. There are so many uses to which liquefied air can be put that scientists hardly know where its usefulness will end if it can be produced at a low rate of cost in commercial quantities. This a new method and machine has accomplished.

Among other advantages, air in the portable, cheap form of a liquid, as it passes back to its ordinary state, can be used for illuminating purposes by mixing its escaping gases with atmospheric air in certain definite proportions. Moreover, as a driving force in the way of detonators or explosive material to drive engines, liquid air is obviously a power that can be, under given conditions, profitably applied.

Hitherto the classic example of a method to liquefy air and obtain oxygen has been that invented by Beatty and Cailletet in 1877. With their machine, one began with carbonic acid gas. By means of a pump this gas was condensed in a tube, round which lay water at 10° to keep the tube cool. The carbonic acid gas, being reduced to a very low temperature, passed from the first tube into another chamber with a tube in it, and in so doing fell to a lower temperature. Into this second tube was pumped at high pressure ethylene gas, which in turn fell to a low temperature, owing to the coldness of the carbonic acid gas bathing the tube. The ethylene gas was then passed from the second tube into a third compartment and fell further in temperature in so doing. The third compartment had likewise a tube with an air pump attached. Into this third tube was pumped oxygen gas and from the ethylene gas bathing it the oxygen gas reached a temperature of 192° below zero. Finally, the oxygen was let out into a fourth compartment, in which was a fourth tube. The air pump attached to this fourth tube having filled it with condensed atmospheric air, the latter was so reduced in temperature that when it in turn was released from the tube, its cold was 273° below zero, and it appeared in the form of drops like water.

This product, which is called liquid or fluid air, has a milky appearance from the presence of some carbonic acid gas, bubbles constantly, and from its enormous cold emits a smoke or cloud like the top of a very high mountain, and will only gradually resolve itself again into air when exposed to the ordinary atmosphere.

Fluid air costs about 10 marks (say $2.35) for five cubic meters reduced. The new method is the invention of Professor Linde, of Munich. It produces the liquid for 10 pfennigs (say 2½ cents) for five cubic meters, and it yields the product either as a gas or fluid, as one wishes. This is one of the most ingenious pieces of mechanism recently known; its chief feature is its economy of working, for it uses air to refrigerate air. After the pump has worked for a certain time, one turns a cock and the liquid air runs out at a temperature of 273° below zero.

In Professor Linde's method an air pump of five horse power condenses air to a pressure of 200 atmospheres; this air passes down a spiral tube and is let out in a chamber, causing great cold; then it rises and passes on the outside of the spiral tube, bathing it and thus cooling the new air that has been pumped into the tube to take its place. This cooled air follows on into the chamber, expands and again lowers its temperature, then passes on up around the same spiral tube; but as its temperature has become much lower, the new air in the tube is still further refrigerated. This circulating process goes on, until the new air pumped into the tube reaches the expansion chamber at a temperature of 273° below zero, when it drops into the chamber in the form of liquid. Thus the air, steadily cooled, is made to refrigerate the newly pumped air more and more, until the necessary degree of cold is attained.

Another idea, which may or may not be an improvement, is to have the pump and all parts of the machine kept very low in temperature.

Air in the cheap, portable form of a liquid rich in oxygen can be used for many purposes in manufactures and the trades. The discovery of a cheap method may be of importance to American manufacturers.

CHARLES DE KAY, Consul-General.

Berlin, March 11, 1897.

BEES IN MEDICINE.

WHEREVER the bee has had a home honey has almost invariably been used both for food and medicine. From the papyri we know that the honey played not an unimportant part in the composition of many of the Egyptian medical potions, and H. H. Sir Bhagvat Sinh Jee, M.D., has told us in his recently issued "History of Aryan Medicine," the role which honey took in the native pharmacopœia of India. Among the medical writers of the past who have alluded to its use may be mentioned Hippocrates and Galen. In the current issue of the St. Bartholomew's Hospital Journal Mr. John Gutch gives some interesting gleanings from old writers who have mentioned bees and honey in a therapeutic connection. Although honey has been used as a medicament, it is not perhaps generally known that not only the sweet product of the bee, but the bee itself has been used in therapeutics. According to the author of the article quoted above, bees drowned in honey have been recommended for clearing the eyes, for staying vomiting, and as useful also for deafness. The curious injunction is given when using the medicine for clearing the eyes that the patient is to be bound, for such is the violence of the medicine that he cannot otherwise patiently endure it. The following remedy is given by Celsus: "The bodies of bees taken newly from the comb and powdered and drunk with Dierretick wine powerfully cures dropsy."—Lancet.

* United States Consular Reports.

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